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CONTENTS

No. 1 MARCH 1951

T. D. STEWART. Scientific responsibility	1
M. F. ASHLEY MONTAGU. The Wallbrook frontal bone. Four figures	5
C. WESLEY DUPERTUIS AND JOHN A. HADDEN, JR. On the reconstruction of stature from long bones. Four figures	15
WILLIAM WALTER GREULICH. The growth and developmental status of Guamanian school children in 1947. Six figures	55
RUTH SANGER, R. J. WALSH AND M. PATRICIA KAY. Blood types of natives of Australia and New Guinea	71
D. A. HOOIJER. Questions relating to a new large anthropoid ape from the Mio-Pliocene of the Siwaliks. One figure	79
EARL W. COUNT. Morris Steggerda — 1900–1950	97
<i>Note:</i>	
WILTON MARION KROGMAN. Fifth recipient of the Viking fund medal and prize in Physical Anthropology	107
<i>Review:</i>	
WILLIAM KING GREGORY, Editor. The anatomy of the gorilla. <i>Reviewed by</i> Walter E. Sullivan	113

No. 2 JUNE 1951

EDWARD B. MILLER, RICHARD E. ROSENFELD AND PETER VOGEL. On the incidence of some of the new blood agglutinogens in Chinese and Negroes	115
JOSÉ DE JS. ALVAREZ. Studies on the A-B-O, M-N, and Rh-Hr blood factors in the Dominican Republic, with special reference to the problem of admixture	127

FREDERICK P. THIEME. An anatomical relationship predisposing to lumbo-sacral fusion. One figure	149
W. W. HOWELLS. Factors of human physique. Four figures	159
J. TORGERSEN. The developmental genetics and evolutionary meaning of the metopic suture. Twenty-two figures	193
WILTON MARION KROGMAN. The role of physical anthropology in dental and medical research	211
<i>Review:</i>	
WILLIAM C. BOYD. Genetics and the races of man. An introduction to modern physical anthropology. <i>Reviewed by</i> Joseph B. Birdsell ...	219
THE AMERICAN ASSOCIATION OF PHYSICAL ANTHROPOLOGISTS. Proceedings of the twentieth annual meeting. Abstracts and list of members	225

No. 3 SEPTEMBER 1951

HERLUF H. STRANDSKOV AND S. L. WASHBURN. Editorial. Genetics and physical anthropology	261
DIRK ALBERT HOOIJER. The geological age of Pithecanthropus, Meganthropus and Gigantopithecus	265
E. H. ASHTON AND S. ZUCKERMAN. Some cranial indices of Plesianthropus and other Primates. Two figures	283
H. S. HALEVI, Y. M. BROMBERG AND A. BRZEZINSKI. Studies in anthropometry of Jewish infants in Palestine	297
MILDRED TROTTER AND GOLDINE GLESER. The effect of ageing on stature	311
STANLEY MARION GARN. The use of middle-phalangeal hair in population studies	325
CHARLES WEER GOFF. Mean posture patterns with new postural values. Two figures	335
BERTRAM S. KRAUS. Male somatotypes among the Japanese of Northern Honshu. Sixteen figures	347
<i>Brief Communications:</i>	
W. C. OSMAN HILL. Note on the nomenclature of certain hominidae ...	367

CONTENTS

V

JURAJ KALLAY. Healed tooth fractures in a Krapina Neanderthal. Six figures	369
R. E. G. ARMATTOE. ABO and RH blood types among the ewes of West Africa	371

Review:

ASHLEY MONTAGU. Statement on Race. <i>Reviewed by</i> Robert W. Ehrich ..	375
---	-----

No. 4 DECEMBER 1951

F. CLARK HOWELL. The place of Neanderthal man in human evolution. Nine figures	379
M. F. ASHLEY MONTAGU. The Barcombe Mills cranial remains. Seven figures	417
MILDRED TROTTER AND GOLDINE C. GLESER. Trends in stature of American Whites and Negroes born between 1840 and 1924. Four figures	427
J. TORGERSEN. Hereditary and environmental factors in twinning. Three figures	441
HAROLD CUMMINS AND FRANK M. SETZLER. Dermatoglyphics in Australian aborigines (Arnhem Land)	455

Brief Communications:

G. H. R. VON KOENIGSWALD. Remarks on <i>Indopithecus</i> : A reply. One figure	461
M. F. ASHLEY MONTAGU. The Piltdown mandible and cranium	464
T. D. STEWART. Objectivity in race classifications	470
HENRY FIELD. Mountain peoples of Iraq and Iran	472
CHARLES E. SNOW. The Kentucky skull rig. Two figures	475

Reviews:

J. LAWRENCE ANGEL. <i>Troy, the Human Remains</i> , <i>Reviewed by</i> Wilton Marion Krogman	478
HERBERT W. RAND. <i>The Chordates</i> . <i>Reviewed by</i> W. W. Ballard	479

SCIENTIFIC RESPONSIBILITY

"The race concept as used in biology is a relatively simple matter," says Prof. Dobzhansky in one of the numerous publications on this subject that have appeared recently.¹ Yet the truth of this statement would seem to be challenged by the variety and scope of these same publications. They offer a choice between the scientific and the popular presentation of race; between brief statements (4 pages) and long books (over 700 pages) on the subject; between the records from the past on race and the prospects for future developments in this field; and between biological race and racism. Such variety of treatment of a simple subject, but particularly the well-meaning efforts of most of the authors to combat race prejudices under the guise of describing race, are succeeding rather, it is to be feared, in confusing the public.

It can be taken for granted that the existence of race prejudices indicates that most people are aware of the differences in external appearance between human groups. To the public, just as to most taxonomists, these external group differences distinguish races. This anatomic race concept has proved intelligible to the layman and useful to the scientist. As Prof. Washburn has pointed out in his *Thinking about Race*, it has provided for the scientist a ready means of classifying most of mankind. The public has a right to be resentful, therefore, when it is told that race is a myth or a fallacy.

¹Dobzhansky, Th. 1950 Nature and Origins of Races. Encyclopedia Americana. Others include:

Boyd, William C. 1950 Genetics and the Races of Man. Boston.

Coon, Carleton S. et al. 1950 Races: A Study of the Problems of Race Formation in Man. Springfield, Ill.

Count, Earl W. 1950 This is Race. New York.

UNESCO 1950 Report on Race. United Nations Department of Public Information, Press and Publications Bureau, Lake Success, N.Y.

Anthropologists may protest that they are saying only that "'race' [note the quotes] is myth." But the subtlety of this distinction, involving the use of the word "race" for racism, contributes to the confusion. An example of this is furnished by the recent UNESCO Report on Race. In section 14 there is the statement that "... for all practical social purposes 'race' is not so much a biological phenomenon as a social myth." This sentence got translated in the press release prepared by the Department of State as "Race [no quotes] is less a biological fact than a social myth." The quotes never reached the public, only the denial of an obvious fact.

Another source of public confusion in this field is the current unrealistic, genetic definition of race. With increasing interest in human genetics more and more anthropologists are succumbing to the criticism from geneticists that race should be based on genotype alone. Accordingly, some are beginning to define race for the public in genetic terms, coupled with statements to the effect that the former definitions are the product of an old-fashioned science employing misconceptions. The public is not so easily fooled. Understandably it is impatient with a definition that does not describe what is seen and speaks only in terms of the mechanism of inheritance. The genetic and anatomic definitions of race are based on different concepts. It only adds to the public's confusion when the same word is used interchangeably for different things.

The idea is being advanced also that races should not only be defined, but they should be classified, on a genetic basis. Since no one can get emotional over something he cannot see, the argument goes, a classification based on genes would avoid all prejudices. This type of reasoning tends to deny the reality as well as the usefulness of the visible physical differences which the public knows so well. Prof. Hooton was not swayed by such arguments when he revised his *Up from the Ape*. The recent advances in genetics forced no

changes in his anatomical way of defining and classifying races.

The science of genetics provides indispensable tools for elucidating the nature of human variations. As yet, however, it has not found, and is not likely to find, a useful substitute for the "old-fashioned" concept of race. As Prof. Coon and his associates say, "race is phenotype." This being the case, it is understandable why the public looks to physical anthropology as the authority on race. No physical anthropologist should damage this confidence by denying the reality of race in the original sense, or by confusing race and racism.

All this does not mean, of course, that the misinterpretation of race differences for ulterior purposes should not be combatted; it does mean that the best weapon in such combat is the truth, unconfused. Keeping the truth inviolate and uncorrupted, as Prof. Shapiro has emphasized in his *Certain Aspects of Race*, is one of the responsibilities of scientists.

T. D. STEWART

The Editor welcomes Dr. Stewart's editorial contribution. Although this does not treat solely of the UNESCO statement, the latter is the most important current exhibit of what Dr. Stewart is talking about, and the Editor shares Dr. Stewart's regrets, in an accompanying letter, that American physical anthropologists have not earlier expressed themselves publicly on the merits of that statement. The professional students of race were astonished to find themselves completely by-passed in the selection of the UNESCO panel and its consultants, but they have not been sufficiently vocal in the past, and are therefore partly to blame themselves.

The attention of readers is called to the January 1951, issue of *Man*, received since Dr. Stewart's communication, which contains a variety of critical commentaries on the UNESCO statement, the most extensive and judicious of which came from Dr. Vallois. The Editor would invite com-

ments of subscribers to this Journal on the subject except for the feeling that this is out of date, since it is understood that a new panel of human biologists including a representative of the American Association of Physical Anthropologists, is in process of formation, to revise the original statement; and also that a series of booklets will be prepared for UNESCO, including one on race and biology by L. C. Dunn and one on the origins of race prejudice by Arnold M. Rose.

The full text of the original statement may be found in the *American Anthropologist*, vol. 53, p. 142. For the record, the summary of conclusions which was contained in the press release of July 18, 1950, is reproduced herewith:

- (1) Racial discrimination has no scientific foundation in biological fact.
- (2) The range of mental capacities in all races is much the same. There is no proof that the groups of mankind differ in intelligence, temperament or other innate mental characteristics.
- (3) Extensive study yields no evidence that race mixture produces biologically bad results. The social results of race mixtures are to be traced to social factors. There is no biological justification for prohibiting inter-marriage between persons of different ethnic groups.
- (4) Race is less a biological fact than a social myth. As a myth it has in recent years taken a heavy toll in human lives and suffering and still keeps millions of persons from normal development, and civilization from the full use of the cooperation of productive minds.
- (5) But, scientifically, no large modern national or religious group is a race. Nor are people who speak a single language, or live in a single geographical area, or share in a single cultural community necessarily a race.
- (6) Tests have shown essential similarity in mental characters among all human racial groups. Given similar degrees of cultural opportunity to realize their potentialities, the average achievement of the members of each ethnic group is about the same.
- (7) All human beings possess educability and adaptability, the traits which more than all others have permitted the development of men's mental capacities.

THE WALLBROOK FRONTAL BONE

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FOUR FIGURES

During World War II excavations were being carried on under the building of the Western Telegraph Company at 22, Great Winchester Street, close to London Wall and near the Wallbrook. The Wallbrook is a district in the center of the City of London — the very hub of London — named after a sizable tributary of the Thames now extinct. An excellent plan of Roman London showing the exact course of the Wallbrook River will be found in Home ('26, facing p. 254). In one of the shafts sunk during the excavations at a depth 17 feet below the street a human frontal bone was recovered by a workman. The find was witnessed by an electrician who was present at the time, and the traces of earth still adherent to the bone correspond with the clayey-gritty soil from which the bone is said to have been recovered.

Since the Wallbrook frontal bone was recovered from a site about 1,000 yards northwest of Lloyds, the site of the London Skull, it is possible that both are derived from the same Upper Floodplain Terrace. The Upper Floodplain Thames Valley Terrace corresponds to the third period of the Last Glacial (Würm).

The Wallbrook site lies in the alluvium which on its eastern flank rises to the Upper Floodplain Terrace. Red gravel occurs at 21 feet below street level (Upper Floodplain Terrace?) and London Clay at 24 feet below street level.

It has been suggested that the Wallbrook frontal may have been derived from the gravel and redeposited in alluvial mud (Zeuner, '47). In such case the bone would be of Upper

Pleistocene age. This is the possibility. The geological evidence being unsatisfactory it can be regarded as no more.

Whether Pleistocene or Recent the Wallbrook frontal possesses one feature of considerable interest, one commonly associated with the cranial bones of Pleistocene man, namely, the marked thickness of the bone. With the exception of its thickness the bone in no way differs morphologically from that of any normal contemporary European male. The bone is mineralized and heavy, and has every appearance of a genuine fossil.

The Wallbrook frontal is complete except for a missing triangular piece with a base of 28.0 mm at the coronal suture and an apex terminating at about one-fourth of the distance (30.0 mm) toward the supraorbital margin, and another missing portion which includes the glabella, the pars nasalis, and a part of the right supraorbital margin. A vertical fracture (post mortem) has separated the right fourth of the bone from the remaining three-fourths. Both portions have been perfectly cemented together (figs. 1 and 3).

Weiner ('47, p. 29) has noted that there is some indication of beginning obliteration of the coronal suture ". . . medially, and also in the endocranial suture line. On the whole the age may be said to be between 30 and 50 years." Since the coronal suture in contemporary Whites of European descent commences obliteration at about 24 years, it is clear that the lower estimate is probably nearer the true age than the higher, although, as is well known, the cranial sutures in prehistoric man appear to have closed at an earlier age than in post-glacial man. The presence of well developed Pacchionian depressions need not modify our estimate of a probable age of about 35 years.

Weiner ('47) in his brief report on the Wallbrook frontal, submitted to the Department of Geochronology of the University of London Institute of Archaeology, pointed out that the thickness at the coronal suture of the Wallbrook frontal was slightly greater than that of the Swanscombe parietal at the coronal suture. He drew attention (p. 29) to the fact that

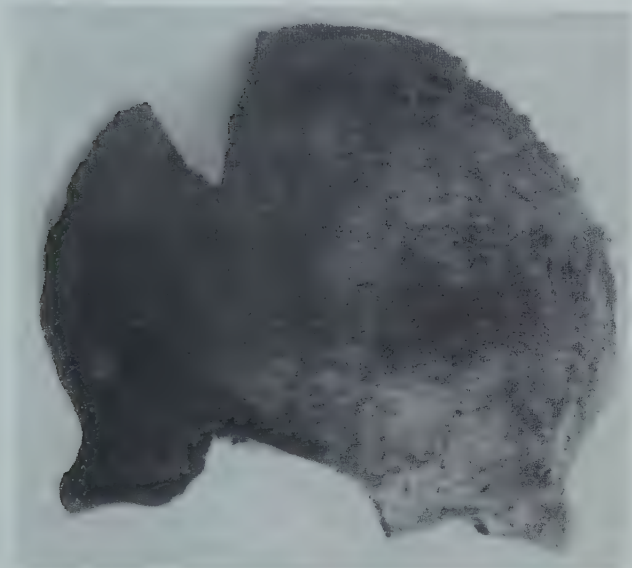


Fig. 1 The Wallbrook frontal. Ecto cranial view. (Courtesy British Museum [Natural History].)



Fig. 2 The Wallbrook frontal. Left lateral view. (Courtesy British Museum [Natural History].)

one of the writers of the Swanscombe report suggested that the unusual thickness of the Swanscombe parietal along the coronal suture “. . . made it not unlikely, that, in spite of the essential modernity of the parietal and occipital, the missing frontal might also show unusual thickness, perhaps of a Neanderthaloid character — witness the Steinheim skull.” The evidence, Weiner adds “so far as it goes, of the present frontal bone, with its thickish coronal border and ‘normal’ supra-orbital region, serves, I think, to indicate that this speculation is not well founded.

“To that extent, the present frontal serves at least as a comment on a rather important point about Swanscombe.”

This seems to me a comment worthy of greater attention than it has yet received. Since Weiner gave no measurements of either the Wallbrook frontal or the Swanscombe parietal, I took the opportunity during a flying visit to Europe to examine both skulls and make the necessary measurements (December 20, 1949).

All measurements given below represent the mean of three measurements taken on the bones themselves.

On the Wallbrook frontal the bi-frontomale width was 109.7 mm, and the bi-stephanion width 124.0 mm. Well developed frontal bosses are present, the distance from the center of one to the center of the other being 65.0 mm. The frontal sinuses are well developed and their height in the median plane from the level of the supraorbital margins is 20.0 mm.

Thickness of the bone at the coronal suture of the Wallbrook frontal and the Swanscombe parietal

PART	WALLBROOK	SWANSCOMBE
At bregmatic portion of coronal suture	7.7 mm	7.4 mm ¹
At middle of coronal suture	7.8 mm	7.3 mm
At inferior parietal angle	3.4 mm	4.0 mm

¹ About 7.0 mm of the inner table of the Swanscombe parietal at the bregmatic angle is broken away. This measurement was made 8.0 mm posteriorly in the sagittal plane where the inner table is intact, and the bone likely to be slightly thicker.

Morant ('38, p. 92) measured the Swanscombe parietal at the coronal border, but he does not give measurements for precise points. He gives the range as 5–8.5 mm, and the "average" as "about 6.5 mm." At the inferior parietal angle I obtained a measurement of 4.0 mm, which is 1.0 mm less than Morant's minimum. For the rest, my measurements fall within Morant's range.

The Wallbrook frontal belonged to a skull which was appreciably smaller than the Swanscombe skull, hence the greater thickness of the Wallbrook frontal at the bregma and the middle of the coronal suture (near stephanion) than at the comparable situation on the parietal is all the more significant.

In the Swanscombe report Morant ('38, p. 94) wrote, "The occurrence of abnormally thick parietal and occipital bones in a specimen of this size is obviously significant, and it suggests forcibly not only that the missing frontal bone was also abnormally thick, but also that it probably possessed a more massive supraorbital region than any modern specimen."

The Wallbrook frontal, even though it belonged to a smaller skull, is thicker than the Swanscombe parietal, and its form is in every way perfectly modern. Hence, the value of the Wallbrook skull lies chiefly in the fact that it proves the Swanscombe skull could have had a frontal bone similar to that of contemporary man. This is not to say the Wallbrook frontal proves that Swanscombe man did have a frontal of contemporary form, but it is to say that the possibility is rendered much more likely than Morant appears to have thought. In this sense the Wallbrook frontal, as Weiner says, constitutes an important comment on the Swanscombe skull.

From the form of the occipital and parietal bones and their joint contour I should say that the probabilities were higher that the Swanscombe skull possessed a frontal bone similar to that of Wallbrook or contemporary man than that it did not.



Fig. 3 The Wallbrook frontal oriented in relation to the Swanscombe bones. Vertical view.
(Courtesy British Museum [Natural History].)

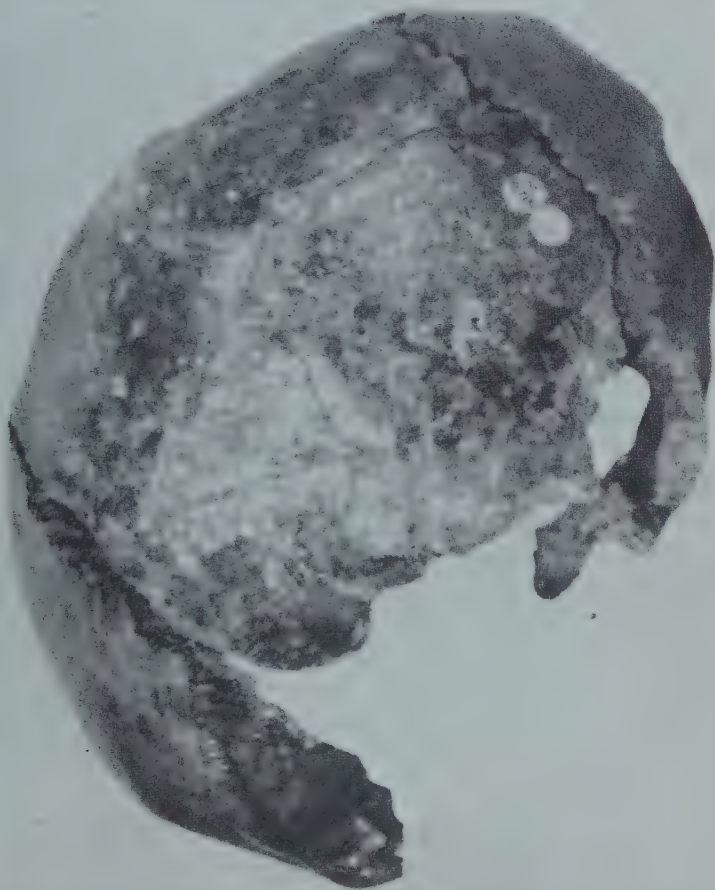


Fig. 4 The Wallbrook frontal and the Swanscombe bones. Approximately three-quarters occipital view. (Courtesy British Museum [Natural History].)

It occurred to me that it might be worthwhile to see how the Wallbrook frontal "shaped up" in relation to the total form of the Swanscombe bones. With the kind assistance of Dr. K. P. Oakley of the British Museum (Natural History) I was able to orient the two Swanscombe bones and to fit the Wallbrook frontal to the Swanscombe parietal. The fit obtained between the Wallbrook frontal and the Swanscombe parietal when the bones were held in the hands was much better than that which could be secured by propping the bones with modelling clay. The fit between the two bones was astonishingly good—much better than one could have expected between such bones taken at random from contemporary crania. Remembering that the Wallbrook frontal belonged to a smaller skull than the Swanscombe skull the good fit between the bones is the more remarkable. The contour of the Swanscombe bones runs smoothly and continuously into that of the Wallbrook frontal. It is difficult to imagine that the Swanscombe skull could have had conjoined to it a bone of any other form (figs. 3 and 4).

Le Gros Clark has published an illustration ('49, fig. 31) showing the left parietal bone of the Swanscombe skull placed in apposition to the right parietal bone of a modern European skull. Except for the greater thickness and darker color of the Swanscombe bone "the two bones appear closely similar." In his next figure (fig. 32) Le Gros Clark has superimposed the Swanscombe bones on an average contour constructed from the top view of a number of modern skulls. The Swanscombe skull fits remarkably closely into the outline of the modern skulls.

On the basis of such considerations as these, strength is added to Le Gros Clark's conclusion ('49, p. 94) that "the remains of the Swanscombe skull suggest that Acheulian Man in Europe was not markedly different in anatomical features from *Homo sapiens*."

As for the antiquity of the Wallbrook skull Oakley ('50) has recently found that the fluorine content of the Wallbrook frontal is 0.7%, while that of Roman skulls from the vicinity

is 0.3%. This finding indicates that the Wallbrook skull probably appreciably antedates the age of Roman Britain. The Lloyds skull, found in clay some 1,000 yards away, has a fluorine content of 0.3%. Elephas from the same clay bed showed a fluorine content of 0.2%, while Rhinoceros from the sand showed a fluorine content of 1.3%. The indications are that the Lloyds skull is not as old as was supposed by some, and that the Wallbrook skull is older than the Lloyds skull. All in all it would seem unlikely that the Wallbrook frontal is older than the Late Upper Pleistocene, and a doubt must remain if it is as old as that.

The Wallbrook frontal is now in the British Museum (Natural History), London. Its register number is M/16514. I owe thanks to the Keeper of the Department of Geology, Mr. G. N. Edwards, for permission to examine the Wallbrook frontal and the Swanscombe bones, and to Dr. Kenneth P. Oakley, of the same Department, for various kind offices in this connection.

SUMMARY

A brief description is given of the Wallbrook frontal bone discovered in London during World War II.

This human frontal bone is said to have been recovered from the clay at a depth of 17 feet below the street level. The geological evidence is ambiguous. If the bone came from the place in which it is said to have been found, it may be of Late Upper Pleistocene age. It is unlikely to be of older age, and a doubt must remain whether it is as old.

The immediate importance of the Wallbrook frontal lies in the fact that it is in every way of modern type and is thicker at the coronal suture than is the Swanscombe parietal at the same suture. In this way the objection is disposed of that the thickness of the Swanscombe parietal and occipital bones rendered it unlikely that the Swanscombe skull could have had a frontal of modern type, that it more probably

"possessed a more massive supraorbital region than any modern specimen" (Morant, '38).

Photographs are reproduced of the Wallbrook frontal oriented in relation to the Swanscombe bones, showing how well the smaller Wallbrook frontal fits the slightly larger Swanscombe bones.

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BLOOD GROUPS IN EGYPT.—The Egyptians show a high frequency (21%) of the B gene. Their MN distribution does not differ significantly from that found in Europe and in other parts of Africa. Their Rh distribution is different from any other yet discovered, with a high frequency of CDe or R₁ (49%) which is probably an ancient Egyptian characteristic, and with 1% of cDe (R₀) chromosomes, a feature probably derived from an admixture of Negro stock.—Joyce A. Donegani, Karima A. Ibrahim, Elizabeth W. Ikin and A. E. Mourant. The blood groups of the people of Egypt. Heredity, vol. 4, pt. 3, December, 1950, pp. 377-382.

ON THE RECONSTRUCTION OF STATURE FROM LONG BONES

C. WESLEY DUPERTUIS AND JOHN A. HADDEN, JR.

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FOUR FIGURES

For many years the need for the revision of the formulae for estimating stature from long bone lengths has been apparent. The same formulae have been in use for the last half century, formulae developed by Pearson in 1899 from data gathered by Rollet (1889). Rollet's measurements were made on 100 cadavers (50 males and 50 females) in his anatomy laboratory at Lyons, France. The long bones were measured soon after dissection, before they were completely dried out. Subsequent experiments by Pearson showed that these measurements were slightly greater than if they had been taken in a dry state, with the animal matter removed. Consequently he applied a correction to the figures given by Rollet so that his formulae could be used on dried bones, the state in which they are ordinarily found.

Rollet's anachronistic means have long been decried. In addition, serious objection has been raised against the Pearson formulae since they are based on measurements taken on a population of fairly short stature, 165 cm and 152.3 cm for males and females respectively, and thus are rather inadequate for estimating living heights of taller people. Applying these formulae, values are obtained for stature which are considerably smaller than the known height. The question has also been raised whether or not the formulae are applicable to other racial groups. Their accuracy when applied to Negroes, for example, whose distributions of stature and long

bone lengths are somewhat different from that of the Whites, is certainly open to question.

It was thought advisable, therefore, to calculate a new set of formulae based on measurements taken from a taller White population and another set based on an even taller Negro population. The material for such a study is available in the Todd osteological collection at Western Reserve University, School of Medicine. This paper presents the results of an attempt to calculate formulae for estimating living stature from dried long bones based on measurements of fairly recent American White and Negro series as represented by the skeletal material in the Todd collection.

DESCRIPTION OF THE MATERIAL

The present study is based on the long bone measurements of 100 adult male White skeletons, 100 adult female White skeletons and an equal number of both sexes of the Negro racial group.

The age range for the two White series is from 20 to 65 years and for the Negroes from 20 to 45 years. Age data on most of the cases are fairly accurately known, having been obtained from hospital records. Where the age was not known we relied on the estimated age calculated according to Todd's methods. These data are available in the records for all the cases studied. Since there were relatively few White skeletons from which to choose, it was necessary, in assembling 100 cases, to include a few whose age at death was between 60 and 65 years. In order to keep the male figures comparable to the female the same general age distribution was selected for this series as was obtained for the females. Table 1 gives the range, distribution and mean of age for the male and female White series.

By including the 16 female cases between 60 and 65 years of age the mean cadaver length for the total series was lowered slightly since their average stature is 2.5 cm shorter than the mean for the whole group. In the case of the males the differ-

ence was very slight. The 60- to 65-year-old group showed a mean stature only .5 cm below that for the total series.

Since there were many more female Negro skeletons from which to select our cases we were not forced to go beyond the range of 20 to 45 years in assembling 100 subjects. The male Negro age distribution was selected to conform as nearly as possible to that of the female Negro series. Table 2 gives the range, distribution and mean age values for the two Negro series.

TABLE 1

Range, distribution and mean of age at death for the White series

	20-29	30-39	40-49	50-59	60-65	TOTAL	MEAN	S.D.
Male	11	15	33	30	11	100	46.49	11.26
Female	9	19	28	28	16	100	47.04	10.96

TABLE 2

Range, distribution and mean of age at death for the Negro series

	20-29	30-39	40-45	TOTAL	MEAN	S.D.
Male	37	47	16	100	32.48	7.03
Female	39	42	19	100	33.34	7.01

All of the long bones measured in this study were from the mascerated cadavers from the gross dissection laboratories of the Western Reserve University, School of Medicine. The skeletons were all in the dried state, having been stored in wooden boxes for periods of from 10 to 20 years. For the most part the bones were in an excellent state of preservation. Interestingly enough the Negro bones were in slightly better condition than the White although they had been prepared in the same manner and had been in their repositories for about the same length of time.

ORIGIN OF THE MATERIAL

For information on the racial and national composition of our White and Negro series perhaps we can do no better than to quote what Professor Todd ('28) has to say on the subject. In the published report on the dimensions of cadavers he says, "Our White population . . . includes very few of French extraction, considerable more of Italian origin, many of British birth or parentage, but the greater number hail, themselves or their parents, from that region of Europe extending from the Rhine to Riga and from the northern seas through the hinterland as far as the Danube. Occasional Balkan people are to be found among our dead." Todd estimates that three-quarters of the cadaver population are foreign born or of first generation of American born. He finds also that more of the females are native born than of the males.

As for the Negroes Todd states that a majority of them are of southern birth, many from Alabama. He says that during the years of World War I there was a great migration of southern Negroes into Cleveland. He further says, ". . . both from the records of the patients and the intrinsic characters of the body we can assure ourselves that our Negro population, though diverse, is by no means so infiltrated with White blood as might appear probable at first glance. . . . I believe this sample to be thoroughly representative of the American Negro, largely uninfluenced by the White, and, therefore, as reliably standing for actual Negro dimensions as any sample can be which is not drawn from the great expanse of Africa, lying behind the western coasts, from which the original ancestors of our Negroes came three hundred years ago."

Todd does not consider either racial series to be a "population of paupers, though many of course are bodies of indigent poor." He says that many bodies are those of persons of middle class birth although the majority are drawn from the lower strata of society. He states that, "these samples represent the population of Cleveland if one except the upper middle class and financially stable part of our community."

In consideration of Todd's description of this cadaver population which was collected under his direction we can probably assume that so far as the Whites are concerned they represent about the usual blend of national and racial groups found in most American midwestern cities and can possibly be taken as rather typical of the White population for the country as a whole. Also from Todd's description of the Negro material we can safely assume that they are not drawn from what is generally known as the Northern Negro with his undetermined admixture of White blood.

TECHNIQUE OF MEASUREMENTS

The statures which were used in calculating our formulae were those made on the cadavers. They were taken in the following manner: the tendons of Achilles were severed and then ice tongs were inserted into the ear holes and the body suspended so that the soles of the feet were firmly planted on the floor. Total body length was measured in this position to the nearest millimeter.

Certain criticisms may be raised as to whether these cadaver lengths correspond to the true standing stature of the living individual. Pearson estimated that Rollet's cadaver lengths, presumably measured in the recumbent position, averaged about 1.2 cm greater than the mean living stature. Also there is some question as to the accuracy of the measurement of total body length in the manner described above. The present writers admit these criticisms but decided to use the mean cadaver lengths as measured in their series for a number of reasons. The coefficients of correlation between long bones and stature for all 4 series are of about the same order as those found by Pearson using Rollet's data. Also the cadaver lengths are probably by and large as representative of standing height as most of the figures derived from studies of living stature made by physical educators, the military or even anthropologists. We do not necessarily agree with Pearson and others that cadaver length is greater on the average than standing living stature. Such is probably not the case if

the observer in measuring the living makes every effort to force his subjects to stretch up to their fullest possible maximum height. Stature taken on individuals who are allowed to stand in a natural easy posture will always be less than the true maximum height of the subject who conscientiously endeavors to stretch up to the fullest extent. Concerning the measurements taken on the suspended cadaver Todd ('28) has this to say, "The resulting measurements are perhaps slightly less than they would be were the individual alive and standing freely by himself but the difference probably does not exceed the error of the measurement . . ."

All of our long bone measurements were made by one observer (CWD). In each case the maximum length of the bone was recorded to the nearest millimeter and the measuring done in the following manner:

1. Femur. Greatest length from internal condyle resting against vertical wall of measuring board, with the bone lying on its dorsal surface, to the extreme point of the head. (No. 1 in Martin, '28, p. 1037.)

2. Tibia. Greatest length from end of malleolus against vertical wall of osteometric board to the anterior edge of the lateral condyle external to the tibial spine. The bone rests on its dorsal surface with its long axis parallel with the long axis of the board. (No. 1 in Martin, p. 1048.)

3. Humerus. Greatest length from end of internal condyle against vertical wall of osteometric board to the extreme point of the head. The bone rests on its dorsal surface. (No. 1 in Martin, p. 1010.)

4. Radius. Greatest length from end of styloid process against vertical wall of osteometric board to extreme point on the head. The bone rests on its anterior surface with its long axis parallel with the long axis of the board. (No. 1 in Martin, p. 1014.)

Both rights and lefts of each long bone were measured but for the calculation of the formulae only the values of the rights were used.

RESULTS OF MEASUREMENTS

Stature or cadaver length

The mean statures or cadaver lengths for the White and Negro series are presented in table 3.

The question of what figures to use for mean adult statures in the development of the formulae for estimating standing

TABLE 3

Stature or cadaver length (in cm)

SERIES	RANGE	MEAN	P.E.	S.D.	P.E.
Male Whites	156-187	172.96 \pm .40		5.88 \pm .28	
Female Whites	144-179	160.96 \pm .46		6.76 \pm .32	
Male Negroes	150-195	176.22 \pm .54		8.00 \pm .38	
Female Negroes	145-180	164.06 \pm .44		6.48 \pm .31	

TABLE 4

Average stature figures for American male White population

GROUP STUDIED	AUTHOR	NO. OF SUBJECTS	MEAN STATURE	
			cm	inches
Soldiers World War I	Davenport and Love ('21)	96,596	171.98	67.71
Old Americans	Hrdlička ('25)	727	174.3	68.62
Century of Progress	Dupertuis	1,474	174.93	68.87
Soldiers World War II	Randall ('49)	42,661	173.49	68.30
Present series (Cadavers)		100	172.96	68.09

height from measurement of dried long bones is a difficult one to answer. We could have followed Pearson's example and taken an estimated average value for the general population in the 4 categories. Mean stature figures are available from several extensive surveys particularly for male Whites. Table 4 lists several of these series. We find here that the mean stature for World War I soldiers is about 172 cm and for

World War II soldiers 173.5 cm. The majority of these men are between the ages of 18 and 35. The former series was measured in 1919 and the latter in 1947. The reasons for the differences of means between the two series is difficult to determine but if we strike an average height value for the two series we arrive at approximately 172.7 cm. This figure could sensibly be taken as a good mean value for the White male population of the United States for the period of 1925-1938. This is the period incidentally when most of the skeletons in the Todd series were collected. The mean age for our male White series at that period was 46.5 years. Our value of 172.96 cm for cadaver length is very close to this calculated mean for the soldiers. It is somewhat lower than the mean values for the Old Americans (174.3 cm) and for the Century of Progress Male White series (174.93 cm). These latter two series, however, are selected in the sense that they come from higher social and economic brackets than is probably true for either the military or our cadaver series. Such groups seem invariably to average taller in stature than the general population.

Since our mean male White cadaver length is reasonably close to an average figure for standing height in the general population we have chosen to use this value in calculating the formulae for this group. Furthermore we prefer to use this value because the standard deviation, which is also used in the construction of the formulae, is derived from this series.

The case for the mean stature of our female White series is similar to that for the male series. Mean stature values for female populations are less numerous than for the males, but a few are available, which give fairly reliable values.

Table 5 shows that the Old American females average 161.85 cm tall. The Century of Progress mean is 162 cm and that for Randall's U. S. Army White series is 162.33 cm. For Diehl's 17,000 White college women the mean is 162 cm. All 4 of these series are fairly selected and their mean statures are probably greater than that for the general population. Our mean of 160.96 cm for the cadaver series seems to be a more reasonable average value for living stature of American women.

When we consider the problem of stature for our Negro series we come up against a different situation. The mean cadaver length of our Negro males is 176.22 cm and for our females 164.06 cm. Now, stature has been recorded on several series of American Negroes as listed in table 6.

TABLE 5

Average stature figures for American female White population

GROUP STUDIED	AUTHOR	NO. OF SUBJECTS	MEAN STATURE	
			cm	inches
Old Americans	Hrdlička ('25)	211	161.85	63.71
Century of Progress	Dupertuis	1,836	162.03	63.79
Army women	Randall ('49)	8,532	162.33	63.91
White college women	Diehl ('33)	17,000	162.0	63.75
Present series (Cadavers)		100	160.96	63.37

TABLE 6

Average stature figures for American Negro population

GROUP STUDIED	AUTHOR	NO. OF SUBJECTS	MEAN STATURE	
<i>Males</i>			<i>cm</i>	<i>inches</i>
Tuskegee students	Steggerda and Petty ('42)	100	174.93	68.86
American Negroes	Herskovits ('30)	887	170.50	67.12
Soldiers World War I	Davenport and Love ('21)	6,441	171.97	67.70
Western Reserve Cadavers	Todd and Lindala ('28)	100	174.38	68.65
Negro criminals	Hooton ¹	766	169.56	66.90
Negro civilians	Hooton ¹	77	169.71	66.92
Present series (Cadavers)		100	176.22	69.38
<i>Females</i>				
Tuskegee students	Steggerda ('40)	100	163.31	64.30
Mississippi Negroes	Herskovits ('31)	157	158.8	62.91
American Negroes	Herskovits ('27)	818	159.0	62.60
American Negroes (General series)	Herskovits ('31)	916	158.65	62.24
Western Reserve Cadavers	Todd and Lindala ('28)	32	158.59	62.44
Present series (Cadavers)		100	164.06	64.59

¹ Personal communication.

From this list of stature means we can conclude that our average height figures run from 4 to 6 cm greater than in the compared series for both sexes. The only groups which come anywhere near ours in mean stature are the Tuskegee students measured by Steggerda. They average 1.29 cm and .75 cm shorter than our series for males and females respectively. Even Todd and Lindala's averages are less than ours in spite of the fact that their subjects were taken from the same collection of skeletons. It should be pointed out, however, that our series probably average younger than theirs since, as indicated above, we were not forced to include older subjects in our series having many more skeletons at our disposal at the time we did our measuring. Otherwise, the difference in height between these two groups of subjects is undoubtedly due to chance since we selected our cases purely at random.

We are left with the fact, then, that our Negro series for some reason or other are a selected group so far as stature is concerned and are not representative in this respect of the American Negroes at large. It is not only the stature which is greater, however, since we find upon examining the mean lengths of the long bones that those of the Negroes are greater than those of our White series.

In spite of the foregoing difficulty we have decided to calculate the formulae for the Negro series from the data we collected. These formulae, after all, are derived from measurements made on Negro subjects and probably reflect to a greater or less degree the situation for the Negro population as a whole. One advantage gained in using this material from an unusually tall group of subjects is to test again the validity of Pearson's formulae which are derived from people of very much lower stature.

Long bone lengths

The mean values for the long bone lengths of the White and Negro series of both sexes is given in table 7. For comparison Pearson's corresponding means are presented in table 8.

Pearson's figures are the ones he used in the construction of his formulae. They are smaller than Rollet's original values since they were corrected to correspond to their length in the dried state.

TABLE 7

Means and standard deviations for the four long bones of Whites and Negroes of both sexes

(All measurements in centimeters)

	WHITES					NEGROES				
	Range	Mean	P.E.	S.D.	P.E.	Range	Mean	P.E.	S.D.	P.E.
MALES										
Femur	40-51	45.33 ± .15		2.26 ± .11		40-54	47.72 ± .18		2.70 ± .13	
Tibia	32-41	36.82 ± .14		2.13 ± .10		32-46	39.82 ± .17		2.55 ± .12	
Humerus	30-37	32.87 ± .08		1.62 ± .08		30-38	33.96 ± .11		1.66 ± .08	
Radius	22-27	24.38 ± .08		1.16 ± .06		22-30	26.50 ± .10		1.50 ± .07	
F + T	72-92	82.15 ± .29		4.25 ± .20		72-98	87.54 ± .34		5.03 ± .24	
H + R	52-63	57.25 ± .18		2.70 ± .13		53-68	60.46 ± .21		3.06 ± .15	
FEMALES										
Femur	34-48	42.24 ± .17		2.53 ± .12		38-49	43.96 ± .15		2.16 ± .10	
Tibia	29-39	33.89 ± .15		2.10 ± .10		32-40	36.36 ± .13		1.94 ± .09	
Humerus	25-34	30.23 ± .10		1.56 ± .07		27-35	31.00 ± .10		1.46 ± .07	
Radius	18-25	21.78 ± .08		1.22 ± .06		20-26	23.70 ± .08		1.14 ± .05	
F + T	63-86	76.14 ± .30		4.48 ± .23		70-90	80.33 ± .28		4.10 ± .20	
H + R	44-58	52.01 ± .18		2.62 ± .12		48-61	54.70 ± .17		2.58 ± .12	

TABLE 8

Corrected means used by Pearson in constructing his formulae¹

	MALE		FEMALE	
	Mean	S.D. ²	Mean	S.D. ²
Stature	165.00	5.50	152.30	5.45
Femur	44.52	2.37	40.86	2.26
Tibia	36.34	1.80	32.97	1.86
Humerus	32.60	1.54	29.36	1.52
Radius	24.39	1.17	21.27	1.10
F + T	80.86	3.98	73.83	4.00
H + R	56.77	2.54	50.63	2.53

¹ From Lee and Pearson (1897).

² Standard deviations calculated from Rollet's original measurements.

It will be observed that the mean values for our different series are larger than those in Pearson's comparable categories. This is to be expected since the average statures of our groups are greater than in his. In every case the Negro means are greater than in either of the White series. Also it is evident that for the most part our several series are less homogeneous than Pearson's as indicated by the larger standard deviations. The one possible exception is found in our Negro female series where this measure of variability is smaller in some instances than the corresponding ones in Pearson's female group.

TABLE 9
Ratios, long bones to stature

	MALE			FEMALE		
	Our White	Negro	Pearson	Our White	Negro	Pearson
F/S	26.2	27.1	27.0	26.2	26.8	26.8
T/S	21.3	22.6	22.0	21.0	22.2	21.6
H/S	19.0	19.3	19.8	18.8	18.9	19.3
R/S	14.1	15.0	14.6	13.5	14.4	14.0
F + T/S	47.5	49.7	49.0	47.3	49.0	48.5
H + R/S	33.1	34.3	34.4	32.3	33.3	33.2

Of considerable interest is the calculation of the long bone lengths as proportions to stature. Table 9 presents these ratios for our series along with Pearson's figures for comparative purposes. Our male and female White long bone-stature ratios are consistently smaller than those for Pearson's series and both are smaller than the corresponding values in the Negro groups. Negroes, then, appear to possess relatively longer limb segments than the Whites. This is particularly true for the tibia and the radius. The figures also show that the females in each category possess relatively shorter mean long bone lengths than do the males.

Sex differences in mean stature and mean long bone lengths are found in table 10.

In each case the ratio is calculated by dividing the average male value by the female and multiplying by 100. It is of note

that our White sex ratios are for the most part smaller than those of our Negroes and that Pearson's values run consistently higher than those of either of our two series. There is a greater difference in stature and long bone lengths between the two sexes among the French population than among our more heterogeneous White group or our predominantly Southern Negro series. American female Whites appear to be taller relative to male stature than is true for the French or the Negroes. The lower sex ratio for stature found in our White series is consistent with corresponding values obtained from Hrdlička's Old Americans (107.7), Randall's Army series (106.9) and the Century of Progress series (107.1). It

TABLE 10
Sex ratios (male/female)

	OUR WHITE	NEGRO	PEARSON
Stature	107.4	107.4	108.3
Femur	107.3	108.6	108.7
Tibia	108.6	109.5	110.1
Humerus	108.7	109.5	110.9
Radius	111.9	111.8	113.5
F + T	107.9	109.0	109.3
H + R	110.1	110.5	112.0

is of interest to note that in all our three compared series the sex ratios increase as one proceeds from the longer to the shorter bones. This phenomenon seems to be a constant feature irrespective of race.

In both the Negro series the distal long bones are longer in proportion to the proximal than is true of either of the White series. Table 11 lists the leg and arm bone indices for the three compared groups. This finding corroborates similar observations made by other investigators. In addition, we find that for all categories the males show higher ratios indicating that they possess relatively longer distal segments than do the females.

As stated above both rights and lefts of all long bones were measured. In comparing the mean values for all categories it was found that for all bones except the femur the rights averaged slightly longer than the lefts. Table 12 gives the amounts to be added to the left bone when it is used in the various formulae.

TABLE 11
Leg and arm bone ratios for the three compared series

	TIBIA/FEMUR	RADIUS/HUMERUS
MALE		
Whites	81.12	74.17
Negroes	83.44	78.03
Pearson's series	81.63	74.82
FEMALE		
Whites	80.23	72.05
Negroes	82.71	76.45
Pearson's series	80.69	72.44

TABLE 12
Amounts in centimeters to be added to left bones when they are used in the various formulae

	FEMUR	TIBIA	HUMERUS	RADIUS
Male White	-.114	+.092	+.125	+.149
Female White	-.041	+.038	+.285	+.224
Male Negro	+.091	+.095	+.012	+.173
Female Negro	-.084	+.072	+.233	+.273

These observations on the mean length differences between rights and lefts corroborate those cited by Pearson quoting Rollet's figures.

For the construction of the formulae it was necessary to calculate the product-moment correlations between stature and the 4 long bones and the intercorrelations between the long bones themselves. Table 13 presents these various correlations for both racial groups and both sexes.

Table 14 gives the intercorrelations between stature and the 4 long bones. In these tables S, F, T, H and R stand for stature, femur, tibia, humerus and radius.

TABLE 13
Correlations between stature and long bones

PAIRS OF ORGANS	MALE	FEMALE
White		
Stature and femur	.8132 \pm .0228	.8690 \pm .0165
Stature and tibia	.7891 \pm .0254	.8458 \pm .0192
Stature and humerus	.6255 \pm .0451	.7958 \pm .0247
Stature and radius	.6804 \pm .0362	.7685 \pm .0276
Stature and femur + tibia	.7747 \pm .0270	.8970 \pm .0132
Stature and humerus + radius	.6851 \pm .0358	.8837 \pm .0148
Negro		
Stature and femur	.8572 \pm .0184	.8328 \pm .0207
Stature and tibia	.8333 \pm .0206	.7548 \pm .0290
Stature and humerus	.7696 \pm .0275	.6839 \pm .0359
Stature and radius	.7575 \pm .0287	.6617 \pm .0379
Stature and femur + tibia	.8876 \pm .0143	.7372 \pm .0308
Stature and humerus + radius	.7508 \pm .0294	.7428 \pm .0302

TABLE 14
Stature and long bone correlations

	S	F	T	H	R
Male White					
S		.8132	.7891	.6255	.6804
F	.8132		.8420	.7766	.7356
T	.7891	.8420		.7399	.8191
H	.6255	.7766	.7399		.7696
R	.6804	.7356	.8191	.7696	
Female White					
S		.8690	.8458	.7958	.7685
F	.8690		.8761	.8447	.8104
T	.8458	.8761		.8277	.8318
H	.7958	.8447	.8277		.8416
R	.7685	.8104	.8318	.8416	
Male Negro					
S		.8572	.8333	.7696	.7575
F	.8572		.8720	.8515	.8135
T	.8333	.8720		.8476	.8718
H	.7696	.8515	.8476		.8313
R	.7575	.8135	.8718	.8313	
Female Negro					
S		.8328	.7548	.6839	.6617
F	.8328		.8592	.8241	.7156
T	.7548	.8592		.8198	.7950
H	.6839	.8241	.8198		.8047
R	.6617	.7156	.7950	.8047	

CONSTRUCTION OF NEW FORMULAE

In the calculation of a new set of formulae for the reconstruction of stature from dried long bones we have considered several possible approaches but finally decided to accept Pearson's (1899) method as the most reliable. In his *Contribution to the Theory of Evolution* he states, "If we know an organ A, then the most probable value of an organ B is that given by the regression formula for the two organs. Let m_a , m_b be the mean sizes of A and B; σ_a , σ_b , their standard deviations, r_{ab} , their coefficient of correlation, then the most probable value of B for a given value of A is,

$$B - m_b = \frac{\sigma_b}{\sigma_a} r_{ab} (A - m_a), \quad (i)$$

or

$$B = (m_b - \frac{\sigma_b}{\sigma_a} r_{ab} m_a) + \frac{\sigma_b}{\sigma_a} r_{ab} A \quad (ii)$$

$$= c_1 + c_2 A \quad (iii)$$

where c_1 and c_2 are constants for the organs under consideration. The probable error of such a determination is $\frac{0.67449 \sigma_b \sqrt{1 - r_{ab}^2}}{\sqrt{p}}$ where p is the population.

For the reconstruction of the most probable value of B from n organs $A_1, A_2, A_3, \dots, A_n$ the general theory of correlation shows that:

$$B = m_b - \frac{R_{01} \sigma_0}{R_{00} \sigma_1} (A_1 - m_1) - \frac{R_{02} \sigma_0}{R_{00} \sigma_2} (A_2 - m_2) \dots \dots \dots - \frac{R_{0n} \sigma_0}{R_{00} \sigma_n} (A_n - m_n) \quad (iv)$$

R is the determinant

$$\begin{vmatrix} 1 & r_{01} & r_{02} & \dots & r_{0n} \\ r_{10} & 1 & r_{12} & \dots & r_{1n} \\ r_{20} & r_{21} & 1 & \dots & r_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ r_{n0} & r_{n1} & r_{n2} & \dots & 1 \end{vmatrix}$$

and R_{pq} , the minor determinant corresponding to r_{pq} , the correlation coefficient of the two organs involved. The probable error of such a determination of B is $\frac{0.67449 \sigma_b \sqrt{R_0/R_{00}}}{\sqrt{p}}$,

Pearson then goes on to discuss the application of these general equations to the specific problem of reconstruction of stature and concludes that they are best suited for the problem. Specifically then the general formula ii may be expressed:

$$S = (m_s - \frac{\sigma_s}{\sigma_1} r_{s1} m_1) + \frac{\sigma_s}{\sigma_1} r_{s1} L \quad (\text{vi})$$

where S is stature; m_s , mean of stature; σ_s , standard deviation of stature; r_{s1} , the correlation coefficient between a long bone and stature; m_1 , the mean of the long bone; and L , the particular long bone used for reconstruction. Similarly for reconstruction from more than one long bone, general formula iv becomes

$$S = m_s - \frac{R_{s1_1} \sigma_s}{R_{ss} \sigma_{1_1}} (L_1 - m_{1_1}) \dots - \frac{R_{s1_n} \sigma_s}{R_{ss} \sigma_{1_n}} (L_n - m_{1_n}) \quad (\text{vii})$$

where R_{s1} is the minor determinant of the correlation coefficient between the long bone in question and the stature.

Our calculated formulae following this method are shown in table 15 along with Pearson's for comparison. With each reconstruction formula a probable error is shown which has been calculated using the equation following general formulae iii and v.

The probable error is in reality the same thing as the standard error of estimate. To obtain the standard error of estimate it is necessary simply to divide the probable errors of table 15 by .067449. Thus the standard error of estimate for calculating stature from femur length in the male White series is $.2308 \div .067449$ or 3.42 cm. It is of interest to note that this figure is 1.1 cm less than the corresponding figure (4.5 cm) cited by Telkkä ('50) in his study of 115 male and female Finnish skeletons.

Both formulae for the probable error show that it is a function of the standard deviation of the stature, the size of the population and directly or indirectly a function of the correlation between the long bones involved and the stature. In their actual values they will reflect on comparison between the categories of race and sex, the differences between the stand-

TABLE 15

Formulae for reconstruction of stature from long bones with probable errors

	PROBABLE ERROR
	cm
<i>A. Our male Whites</i>	
a. $S = 77.048 + 2.116 F$	0.2308
b. $S = 92.766 + 2.178 T$	0.2436
c. $S = 98.341 + 2.270 H$	0.3094
d. $S = 88.881 + 3.449 R$	0.2907
e. $S = 84.898 + 1.072 (F + T)$	0.2508
f. $S = 87.543 + 1.492 (H + R)$	0.2889
g. $S = 76.201 + 1.330 F + 0.991 T$	0.2173
h. $S = 82.831 + 0.907 H + 2.474 R$	0.2835
i. $S = 78.261 + 2.129 F - 0.055 H$	0.2328
j. $S = 88.581 + 1.945 T + 0.524 R$	0.2385
k. $S = 52.618 + 1.512 F + 0.927 T - 0.490 H + 1.386 R$	0.1582
<i>B. Our female Whites</i>	
a. $S = 62.872 + 2.322 F$	0.2256
b. $S = 71.652 + 2.635 T$	0.2433
c. $S = 56.727 + 3.448 H$	0.2762
d. $S = 68.238 + 4.258 R$	0.2963
e. $S = 57.872 + 1.354 (F + T)$	0.2016
f. $S = 42.386 + 2.280 (H + R)$	0.2134
g. $S = 60.377 + 1.472 F + 1.133 T$	0.2063
h. $S = 53.187 + 2.213 H + 1.877 R$	0.2632
i. $S = 55.179 + 1.835 F + 0.935 H$	0.1827
j. $S = 64.702 + 2.089 T + 1.169 R$	0.2328
k. $S = 56.660 - 1.267 F + 0.992 T + 0.449 H + 0.164 R$	0.2068
<i>C. Male Negroes</i>	
a. $S = 55.021 + 2.540 F$	0.2819
b. $S = 72.123 + 2.614 T$	0.2983
c. $S = 50.263 + 3.709 H$	0.3445
d. $S = 69.168 + 4.040 R$	0.3522
e. $S = 52.702 + 1.411 (F + T)$	0.2485
f. $S = 57.601 + 1.962 (H + R)$	0.3564
g. $S = 54.438 + 1.615 F + 1.123 T$	0.2559
h. $S = 48.275 + 2.182 H + 2.032 R$	0.3251
i. $S = 48.802 + 2.175 F + 0.696 H$	0.2749
j. $S = 67.964 + 2.260 T + 0.689 R$	0.2964
k. $S = 53.873 + 1.637 F + 1.101 T + 0.084 H - 0.093 R$	0.2626

TABLE 15 (continued)

Formulae for reconstruction of stature from long bones with probable errors

	PROBABLE ERROR
	cm
<i>D. Female Negroes</i>	
a. $S = 54.235 + 2.498 F$	0.2419
b. $S = 72.391 + 2.521 T$	0.2867
c. $S = 69.978 + 3.035 H$	0.3189
d. $S = 74.906 + 3.761 R$	0.3277
e. $S = 70.584 + 1.165 (F + T)$	0.2953
f. $S = 61.982 + 1.866 (H + R)$	0.2926
g. $S = 52.989 + 2.112 F + 0.501 T$	0.2397
h. $S = 62.402 + 1.906 H + 1.796 R$	0.3082
i. $S = 55.103 + 2.517 F - 0.033 H$	0.2380
j. $S = 66.005 + 2.076 T + 0.952 R$	0.2832
k. $S = 53.342 + 2.201 F + 0.359 T - 0.663 H + 0.930 R$	0.2365
<i>E. Pearson's male Whites</i>	
a. $S = 81.306 + 1.880 F$	0.3047
b. $S = 78.664 + 2.376 T$	0.3275
c. $S = 70.641 + 2.894 H$	0.3056
d. $S = 85.925 + 3.271 R$	0.3728
e. $S = 71.272 + 1.159 (F + T)$	0.2835
f. $S = 66.855 + 1.730 (H + R)$	0.3139
g. $S = 71.443 + 1.220 F + 1.080 T$	0.2845
h. $S = 69.788 + 2.769 H + 0.195 R$	0.3054
i. $S = 68.397 + 1.030 F + 1.557 H$	0.2750
j. (not calculated)	
k. $S = 67.049 + 0.913 F + 0.600 T + 1.225 H - 0.187 R$	0.2748
<i>F. Pearson's female Whites</i>	
a. $S = 72.844 + 1.945 F$	0.3058
b. $S = 74.774 + 2.352 T$	0.3146
c. $S = 71.475 + 2.754 H$	0.3284
d. $S = 81.224 + 3.343 R$	0.3816
e. $S = 69.154 + 1.126 (F + T)$	0.2898
f. $S = 69.911 + 1.628 (H + R)$	0.3380
g. $S = 69.561 + 1.117 F + 1.125 T$	0.2922
h. $S = 70.542 + 2.582 H + 0.281 R$	0.3279
i. $S = 67.435 + 1.339 F + 1.027 H$	0.2971
j. (not calculated)	
k. $S = 67.469 + 0.782 F + 1.120 T + 1.059 H - 0.711 R$	0.2836

ard deviations of stature and the sizes of the populations. Thus the probable errors for our White series are generally lower than those of the Negroes because of the difference in their standard deviations, and are lower than the French Whites because of the larger samples.

The relative value within each category of race and sex may perhaps be an indication of the accuracy of prediction of stature from a particular type of formula. Table 16 shows the

TABLE 16

Rank order of increasing magnitude of probable errors of reconstruction formulae in each category of race and sex

RACE Sex	OUR WHITES		NEGROES		PEARSON'S WHITES	
	Male	Female	Male	Female	Male	Female
<i>Formula</i>						
a.	3			4		
b.						
c.						
d.						
e.		2	1		3	2
f.						
g.	2	3	2	3	4	3
h.						
i.	4	1	4	2	2	4
j.						
k.	1	4	3	1	1	1

increasing magnitude of the probable errors of each category by ranking numbers from 1 to 4. From it, formulae e, g, i, and k show the least probable error.

It should be noted here that these formulae all have two or more long bones in them, either combined as $F + T$ or with separate coefficients. And they include only one of the formulae which use the radius in any way, the four-membered formula. Thus the radius would appear from this to be the least reliable bone for prediction.

DISCUSSION

In an analysis of these formulae for reconstruction of stature, just what they represent should be kept clearly in mind. Each one is a description of a line running through the center of the population whose stature is plotted against one or more long bone lengths. Thus in figure 1 the line representing the formula for the reconstruction of the stature of our male Whites from their femora lies in the middle of the plot of that population. The same is true for the Negroes. Each of these lines has a slope as indicated by the factor c_2 in general formula iii, $B = c_1 + c_2A$, and the origin of each is determined by c_1 . Thus in figures 1 and 2 we are able to plot in addition Pearson's formula for the femur for comparison. On each we have indicated the position of the mean of the distribution.

Figures 3 and 4 show all of the formulae which can be presented in this way. The difficulty in representing those formulae with more than one variable is readily apparent, but for a discussion of the differences between the various categories the graphic representation of the formulae of a single variable is sufficient.

In the accuracy of prediction of a stature from any given femur it can be seen in figure 1 that, if the location of the plot of its stature and femur lies closer to the line for our male White formula than it does to Pearson's, then ours will give the better results. On the other hand if it lies closer to Pearson's then his will give a more accurate prediction. If we consider the Negro formula at the same time and find that the plot lies between the lines for the Whites and closer to it than to the Whites, it will give the best results.

If we estimate which of these formulae in figure 1 gives the best results by counting the number of our White population lying closest to each line, we find that our male White formula gives the best prediction in 64% of the population, 28% using the Negro formula, and 8% using Pearson's. If we disregard the line for the Negro formula ours then gives the better results in 86% of the cases, Pearson's in 14%. In estimating stature from our Negro population in the same way, the Negro

formula gives best results in 40%, our White formula in 37%, and Pearson's in 23%. If the Negro formula is omitted ours then gives better prediction in 66%. If ours is omitted, the Negro is better in 77%, and if Pearson's is left out, then the Negro shows better results in 63%.

This shows, as would be expected, that each of the formulae gives the best results when it is applied to the population from

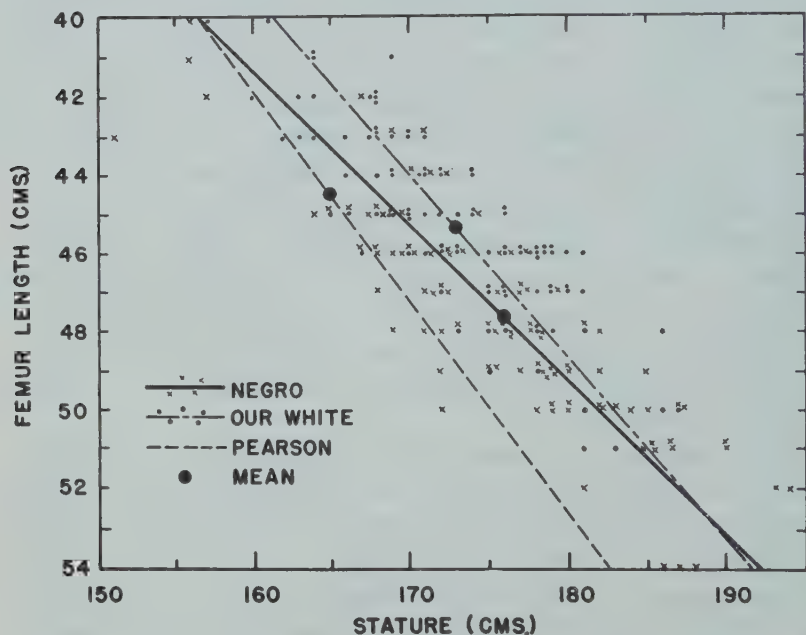


Fig. 1 Scattergram of stature and femur distribution for our male White and Negro series and regression lines representing reconstruction formulae of stature from femur for these and Pearson's series.

which it was constructed. However, it shows further that the formulae for both our Whites and our Negroes, when applied to their opposite population are better than Pearson's. This is explained by the fact that our two populations as represented by the lines of their formulae are closer to each other than Pearson's is to either one. We can make this a generalization on the basis of figures 3 and 4, noting at the same time the

exception seen in the formulae for reconstruction from the radii of both males and females.

The comparison of all of the formulae including those of more than one variable can be made in a different manner. If we apply all those of our male Whites, for example, to the corresponding means of our male White long bones, we should expect to get no deviation from our mean stature in the result. If, however, we use all of Pearson's male formulae on our male

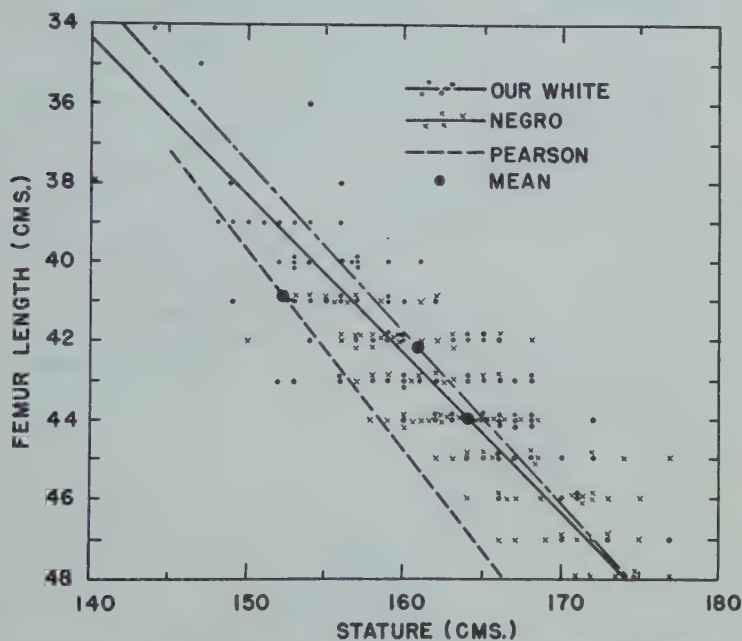


Fig. 2 Scattergram of stature and femur distribution for our female White and Negro series and regression lines representing reconstruction formulae of stature from femur for these and Pearson's series.

White long bone means, we get a mean deviation from our observed mean of — 6.85 cm. This is what we might expect if we look back at figure 1. The mean femur length there is 45.33 cm. Applying Pearson's formula to this length we would get a stature of 166.53. This is 6.43 cm less than the true mean. The reason explained graphically for this is that the line representing Pearson's formula at that point is 6.43 cm to the left of ours.

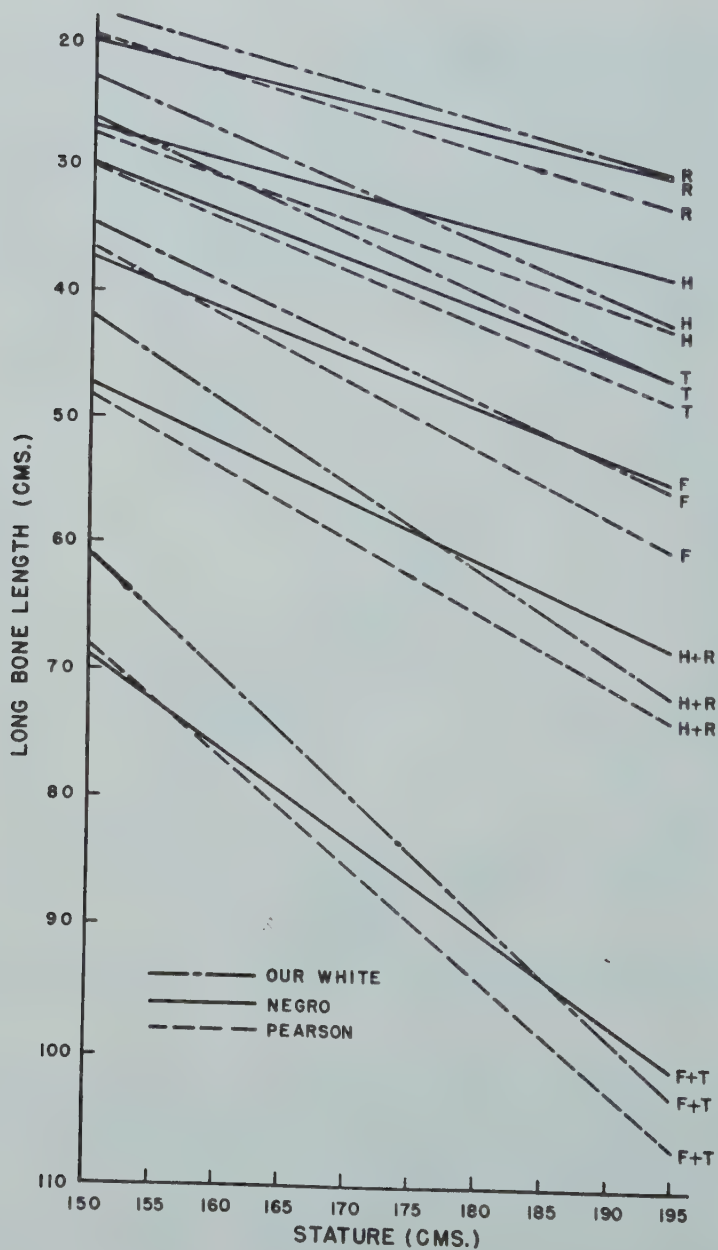


Fig. 3 Regression lines representing reconstruction formulae for male stature from various long bones.

Table 17 shows the mean deviations for all categories. The formulae of each category were applied to the means of the long bone lengths of both its own and the other categories of the same sex.

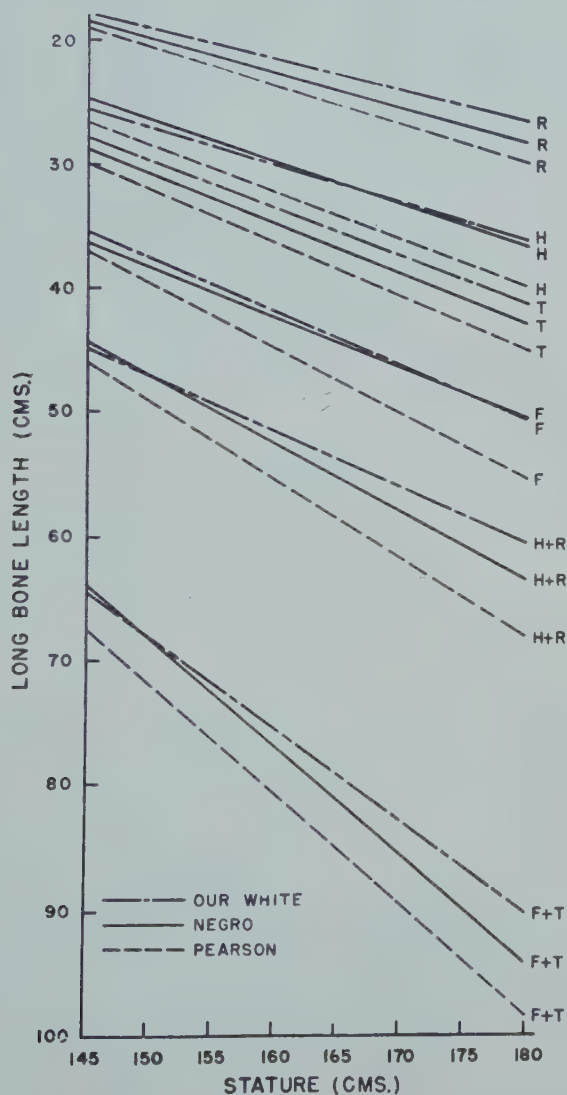


Fig. 4 Regression lines representing reconstruction formulae for female stature from various long bones.

As table 17 shows, the Negro formulae give the least mean deviation. The graphs in figures 3 and 4 bear this out. In almost every type of formula represented there the line of the Negro equation runs between those of the two white groups, in the area of the distribution of the population. The greatest deviations will be seen to occur when Pearson's formulae are applied to the other means and when our White formulae are used on his means. This serves to emphasize the difference

TABLE 17

Mean deviation from the observed mean stature using all categories of formulae on average long bone lengths

	OUR MALE WHITE FORMULAE	OUR MALE NEGRO FORMULAE	PEARSON'S MALE WHITE FORMULAE
<i>Male</i>			
Our long bone means			
Male White	0	— 3.57	— 6.85
Our long bone means			
Male Negro	+ 2.63	0	— 4.80
Pearson's long bone means			
Male White	+ 6.77	+ 2.90	0
	OUR FEMALE WHITE FORMULAE	OUR FEMALE NEGRO FORMULAE	PEARSON'S FEMALE FORMULAE
<i>Female</i>			
Our long bone means			
Female White	0	— 1.97	— 6.23
Our long bone means			
Female Negro	+ 2.38	0	— 5.26
Pearson's long bone means			
Female White	+ 5.74	+ 3.92	0

between the two populations and what poor results the formulae of one group give on the other's mean long bone lengths.

Another way in which we can compare the accuracy of prediction of stature is to apply both Pearson's and our White formulae to 10 White skeletons and similarly using Pearson's and our White formulae on 10 Negroes taken at random from our population and observe the mean error from the known cadaver lengths. Table 18 shows a summary of these mean errors.

They are again what should be expected if the graphs are kept in mind. Pearson's will always give a greater mean error than the one constructed from the population being tested. In addition his will give less of a mean error on the Negroes than on the Whites and also less on the males than on the females, the female lines being separated in the range of population distribution by a greater distance than the males.

There are several reasons for the discrepancies in prediction of stature between Pearson's and our formulae. Figures 3 and 4 show that the lines of Pearson's formulae are all to the left of ours. Thus for any given length of long bone ours will give a greater stature. Pearson's, as we have noted, has used

TABLE 18

Mean error (cm) in prediction of stature of 10 skeletons taken at random from our Negro and White populations

	POPULATION			
	Male		Female	
	Our White	Negro	Our White	Negro
<i>Formula</i>				
Our White	2.85	3.01	2.80	3.34
Pearson	5.94	5.11	6.14	6.12

a mean stature of 165.0 cm, which he has taken as a generally accepted figure for the French population, whereas Rollet's mean male cadaver length was 166.26 cm. Had Pearson used this instead of 165.0, the discrepancies seen would be correspondingly less. The real reason, however, for the difference is to be found in the ratio of long bones to stature. It was shown in table 9 that Pearson's long bone stature ratios, calculated from his corrected lengths and the estimated stature, are in all cases greater than those of our Whites. Thus for any given stature our Whites have shorter long bones than do the French. Is this an inherent difference or is it an artificial one introduced by the fact that Pearson took an arbitrary stature value and we relied on measured cadaver lengths? The point could be

made that our cadavers were stretched beyond living stature, thus rendering our long bones relatively shorter when calculated as proportions of these lengths. Pearson claims that Rollet's cadaver lengths are greater than the average living stature of the French people; Todd claims that his cadaver lengths are probably less than standing living heights.

Our long bone-stature ratios are calculated from the dried long bones and cadaver lengths. If we calculate a set of ratios using Pearson's long bone means, corrected to the dry state, and Rollet's cadaver lengths we should have a situation more comparable to ours. Table 19 presents these two sets of ratios. Here we find that in both sexes and for all categories the

TABLE 19
Ratio of long bones to stature — Whites

	OUR DRIED LONG BONE MEANS		PEARSON'S CORRECTED LONG BONE MEANS	
	MEAN CADAVER LENGTHS		ROLLET'S MEAN CADAVER LENGTHS	
	Male	Female	Male	Female
Femur	26.2	26.2	26.7	26.5
Tibia	21.3	21.1	21.8	21.4
Humerus	19.0	18.8	19.6	19.1
Radius	14.1	13.5	14.5	13.8
F + T	47.5	47.3	48.6	47.9
H + R	33.1	32.3	34.1	36.3

French population has greater long bone lengths relative to cadaver lengths than do our American Whites. The differences, however, are less than those between our ratios and Pearson's using the estimated stature for the French.

The evidence at hand would seem to suggest that our American White population has shorter long bones relative to stature than did the French of 1890. That these are inherent differences in the two populations seem a reasonable conjecture. Whether or not it is due to a difference in racial composition of the two samples or to some other unknown etiological factor is difficult to say. The racial theory seems to be supported by the evidence of the Negro figures where, as we have

seen (table 9), all of their long bones except humerus are longer relative to stature than is true for the White population. This is a restatement of a well documented fact. Were the Negroes stretched in measuring, their ratios would be smaller and closer to Pearson's and ours. Since this is not the case, we may assume that little stretching has taken place in the measuring of the Negroes and so similarly with our Whites. Thus the latter's ratios are presumably valid.

Because of the magnitude of the deviations seen in the cases where formulae are applied to a population other than that from which they were constructed (as in the case of the formulae of our Whites used on Pearson's means and vice versa) we feel that with the data at hand general formulae should be presented. They should include all of the data at hand and at the same time give smaller deviations when applied to any means than do those of the specific formulae giving large deviations of 6 or more centimeters. Consequently we have calculated general formulae by averaging the slopes and origins of the three formulae for the same long bone from each racial group, weighting each according to the number in the respective population. Pearson's population numbering 50 of each sex was given only half the weighting of our two series of 100 each for both sexes. These general formulae appear in table 20.

We are fully aware of the limitations of this method of constructing such formulae. However, since the individual records of Rollet's population are unavailable, this is the only way in which his group may be included in such a generalization. Because the two White groups and the Negroes are in very much the same range, little appreciable error is introduced using this method.

As was done in table 17, we have determined the mean deviation that these formulae give when they are applied to the long bone means of the various racial groups. These mean deviations are seen in table 21. One can see here in comparison with table 17 that the general formulae give better results on the White groups than do the formulae of either White group when applied to the other's means. Pearson's formulae when

applied to our Whites gives a deviation of — 6.85, whereas the general formulae gives only — 2.11. On the other hand, the general formulae are certainly no better than the Negro formulae but they are quite comparable. Both give very small deviations on the Negro long bone means and in some cases the Negro gives better results on the Whites and in some cases

TABLE 20

General formulae for reconstruction of stature from long bone lengths

MALE	
a.	$S = 69.089 + 2.238 F$
b.	$S = 81.688 + 2.392 T$
c.	$S = 73.570 + 2.970 H$
d.	$S = 80.405 + 3.650 R$
e.	$S = 69.294 + 1.225 (F + T)$
f.	$S = 71.429 + 1.728 (H + R)$
g.	$S = 66.544 + 1.422 F + 1.062 T$
h.	$S = 66.400 + 1.789 H + 1.841 R$
i.	$S = 64.505 + 1.928 F + 0.568 H$
j.	$S = 78.272 + 2.102 T + 0.606 R^1$
k.	$S = 56.006 + 1.442 F + 0.931 T + 0.083 H + 0.480 R$
FEMALE	
a.	$S = 61.412 + 2.317 F$
b.	$S = 72.572 + 2.533 T$
c.	$S = 64.977 + 3.144 H$
d.	$S = 73.502 + 3.876 R$
e.	$S = 65.213 + 1.233 (F + T)$
f.	$S = 55.729 + 1.984 (H + R)$
g.	$S = 59.259 + 1.657 F + 0.879 T$
h.	$S = 60.344 + 2.164 H + 1.525 R$
i.	$S = 57.600 + 2.009 F + 0.566 H$
j.	$S = 65.354 + 2.082 T + 1.060 R^1$
k.	$S = 57.495 + 1.544 F + 0.764 T + 0.126 H + 0.295 R$

¹ Formula "j" includes only the data of our series. Pearson did not construct any of this type.

the general formulae do. The reason for this is that the single variable general formulae graphically would coincide most closely with the Negro, both lying for the most part between the two White groups.

The question can readily be raised now as to which formula should be used in any particular instance. Should the general

formulae be applied in all cases or should they be used in cases where there is some doubt as to racial background? Certainly if the subject is known to be a recent Negro, the Negro formulae probably should be employed. If he is known to be a White, should our White or Pearson's formulae be used? The general rule we suggest is that Pearson's should be used when the long bone in question is shorter or close to his mean for that bone, ours should be applied when the long bone is close to or greater than our mean, and the general formulae be used when the length is between the means of the two groups. If the race is unknown, the general formulae are probably best. If the sex is unidentifiable, we suggest that the general for-

TABLE 21

*Average deviations from the observed mean stature using general formulae
on average long bone lengths*

	MALE	FEMALE
Our long bone means — White	— 2.11	— 2.64
Our long bone means — Negro	— 0.07	+ 0.30
Pearson's long bone means	+ 3.75	+ 4.17

mulae for the sex whose mean in our White series is closest to the long bone be used.

As an example of the variations in height obtained by using the different sets of formulae, we have calculated stature from the long bone figures of several skeletal series cited by Pearson. Table 22 presents these mean stature values using our White, the general formulae and Pearson's formulae. In this listing, the number of skeletons represented varies from 1 to 127 in the different series. In some cases, such as Cro-Magnon II, only the humerus and tibia lengths were available; hence only formulae b and c were used. In some instances figures for all 4 long bones are given by Pearson but the number of individual bones varies considerably. For the Naqada race, for example, there were fewer humeri and radii represented than femora, nevertheless, all 11 formulae were used and the figures

given in table 23 are the average values derived from the complete set of formulae.

Table 23 presents the mean values for the long bone lengths as given by Pearson for these various skeletal series. The numbers of individual bones from which these means were calculated are also indicated in this table. In addition we have

TABLE 22

Mean statures calculated from long bone figures cited by Pearson

	NO. OF SKELETONS REPRESENTED		OUR WHITE FORMULAE	GENERAL FORMULAE	PEARSON'S FORMULAE
	<i>Sex</i>	<i>No.</i>	<i>cm</i>	<i>cm</i>	<i>cm</i>
<i>Palaeolithic man</i>					
Neanderthal	M	5	170.8	167.4	163.0
Spy	M	1	166.6	163.2	160.3
Chancelade	M	1	164.4	162.9	157.5
Cro-Magnon I	M	1	179.2	176.9	172.7
Cro-Magnon II	M	1	172.8	170.1	165.7
<i>Neolithic man</i>					
Great Britain	M	25	173.8	171.4	167.3
Great Britain	F	5	159.3	157.6	153.6
France and Belgium	M	127	170.0	166.7	162.5
France and Belgium	F	53	157.4	155.6	151.4
<i>Post-Neolithic</i>					
Naqada race	M	80	175.2	172.3	167.5
Naqada race	F	113	163.1	161.0	156.0
Round Barrow	M	27	178.1	176.0	171.1
Romano-British	M	10	173.2	170.7	166.7
Romano-Gauls	M	40	171.9	168.9	164.8
Rowgrave pop. of South Germany	M	41	176.2	173.6	169.2
Rowgrave pop. of South Germany	F	16	161.2	159.1	154.5
Anglo Saxons	M	65	177.4	174.9	170.9
Anglo Saxons	F	26	162.2	160.5	156.0
Wittenham Peasantry	M	23	175.8	173.6	169.1
Wittenham Peasantry	F	17	160.9	159.3	155.0
Franks 500-800 A.D.	M	47	173.0	170.6	166.4
Franks 500-800 A.D.	F	16	157.9	156.2	152.1

included for comparison the mean long bone figures for our White and Pearson's series of both sexes.

Inspection of table 22 reveals that in every instance our White formulae give higher stature figures for the various groups than do Pearson's. The average difference between the two sets of stature values is about 7 cm for the males and 5.9 cm for the females. Whether the figures for stature as calculated from our White formulae are too high or those from Pearson's formulae are too low on the average or for individual groups is a question which deserves some consideration.

For the Neanderthal man, represented by 5 femora, 5 humeri and 5 radii our White formulae give 170.8 cm as an average figure for stature as compared to 163.0 cm using Pearson's formulae. In this instance, since the mean values for the lengths of the long bones (femur 44.5 cm, humerus 31.2 cm, radius 24.0 cm) are closer to those of the Pearson's original French cadaver series man to ours, we feel justified in assuming that his formulae give a more accurate estimate of stature for this group. Furthermore it seems apparent that the value of 167.4 cm derived by using the general formulae also is too high.

By way of contrast if we consider the Naqada race, it is probable that our White formulae give more accurate stature estimates. For the 80 male skeletons represented the mean values in centimeters for the 4 long bones are: femur 45.93, tibia 37.97, humerus 32.62 and radius 25.70. All of these means (except humerus) are greater than the averages for our White series and all are considerably greater than for Pearson's series. It seems reasonable in this case to accept the figure 175.2 cm as given by our White formulae as more nearly representative of the true stature for this race.

Pearson's figure of 167.5 cm is probably too low an estimate considering the fairly high long bone mean values. The figure of 165 cm for the male French population on which Pearson based his calculations had values of 45.52 cm for mean femur length and 36.34 cm for mean tibia length. These two figures added together give 80.86 cm. The corresponding value for the

TABLE 23
Mean lengths of long bones for various series cited by Pearson
 (Values in centimeters)

	SEX	FEMUR		TIBIA		HUMERUS		RADIUS	
		No.	Mean length	No.	Mean length	No.	Mean length	No.	Mean length
<i>Palaeolithic man</i>									
Neanderthal	M	5	44.52						
Spy	M	1	43.32	1	33.0	5	31.2	5	24.0
Chancelade	M	1	40.8						
Cro-Magnon I	M	1	48.32	1	39.5	1	30.0	1	23.6
Cro-Magnon II	M			1	37.5	1	32.1		
<i>Neolithic man</i>									
Great Britain	M	25	45.75						
Great Britain	F	5	41.53						
France and Belgium	M	127	43.99	133	35.87	127	31.08	49	23.54
France and Belgium	F	53	40.10	79	33.11	45	28.58	18	21.76
Naqada Race	M	80	45.93	85	37.97	62	32.62	47	25.70
Naqada Race	F	113	42.63	115	34.96	97	29.87	66	23.33
Round Barrow	M	27	47.75						
Romano-British	M	10	45.72						
Romano-Gauls	M	40	45.52	22	35.9	18	32.0	9	24.1
Rowgrave pop.: S. Ger.	M	41	46.99	25	38.5	17	33.71	11	25.41
Rowgrave pop.: S. Ger.	F	16	41.07	7	33.71	9	30.28	4	23.10
Anglo Saxons	M	65	47.17	12	39.05				
Anglo Saxons	F	26	42.77						
Wittenham Peasantry	M	23	46.69						
Wittenham Peasantry	F	17	42.24						
Franks (500-800 A.D.)	M	47	45.18	31	36.81	23	33.23	7	25.31
Franks (500-800 A.D.)	F	16	40.87	7	32.77	8	29.39	3	22.80
Present study: Whites	M	100	45.33	100	36.82	100	32.87	100	24.38
Present study: Whites	F	100	42.24	100	33.89	100	30.23	100	21.78
Pearson's series	M	50	44.52	50	36.34	50	32.60	50	24.39
Pearson's series	F	50	40.86	50	32.97	50	29.36	50	21.27

femur plus tibia means for the Naqada race males is 83.90 cm. Thus in the leg alone the Naqada males are more than 3 cm longer than the Frenchmen. Their overall stature must have been considerably greater than the 167.5 cm estimated by Pearson since this figure is only 2.5 cm greater than the mean stature for the Frenchmen. From this it seems probable that the value of 175.2 cm obtained from our White formulae is more nearly the correct estimate of mean stature for the Naqada race. We are assuming, of course, that the Naqada males possessed more or less the same leg to stature proportions as Rollet's and our cadaver series. It is conceivable that in spite of having long legs, the Naqada males may have had very short trunks. In that case Pearson's figure of 167.5 cm for their stature could be correct. If the ratio of the two leg bones to stature for the Naqada males was the same as it was for Pearson's French series (49.0%) then by the calculation of a simple proportion we arrive at a figure of 171.35 cm for stature based on their average long bone lengths. This is far above Pearson's figure of 167.5 cm. By the same reasoning if their $(F + T)/S$ ratio was the same as that for our White series, 47.5% (table 9), we would arrive at a value of 176.75 cm for their stature. We do not know, of course, whether the Naqada had long, average or short trunks but from the length of their leg bones it seems reasonable to conclude that their average stature must have been between 170 and 175 cm and probably closer to the latter figure. At this point we could resort to using the general formulae giving the figure of 172.3 cm for the Naqada male stature. This would be a compromise but might conceivably be the most nearly correct estimate.

Table 23 shows that there are several series in which the mean long bone lengths are greater than in our White series and several in which they are lower than those of Pearson's Frenchmen. This suggests that we are dealing here with groups of people whose stature varies from fairly short to fairly tall. From what we have seen earlier in this discussion there appears to be no one set of formulae which is equally applicable to the estimation of stature for groups of peoples

of great diversity of statures. Pearson's formulae appear to give good results for people of short statures; our White formulae give best results for taller groups. The general formulae may be best suited for most purposes but admittedly they are a compromise.

The question may well be raised as to how accurate are our estimates of living heights of ancient man? If we accept the results as calculated from Pearson's formulae, we should have to conclude that the majority of early men were of short stature. Figures derived from our White or our general formulae indicate little difference in standing height between ancient and modern man. The whole problem revolves, of course, around the question of how representative the available bones are of the population under consideration. Single bone specimens may be longer or shorter than the average for a large series. Thus estimates of stature from them may give quite erroneous impressions of the true living heights for the group as a whole. There is no way out of this difficulty save the unearthing of more long bones. More accurate tentative estimates of early man's stature may be made, however, by employing, in the study of any particular bone, that formula which was derived from bones of comparable dimensions.

SUMMARY

The need of the recalculation of Pearson's formulae for the reconstruction of stature from long bone lengths has been apparent for some time. Data for revision of the formulae was obtained from the Todd Osteological Collection at Western Reserve University. Measurements of cadaver length and long bones were made on groups of 100 male and 100 female American Whites and an equal number of both sexes of Negroes. According to Todd, the White cadaver population represented the usual blend of national and racial groups found in most American midwestern cities. The majority of the Negroes were of southern birth and relatively free of White admixture.

The cadaver statures were measured by the suspension method and the long bones were measured according to stand-

ard anthropological methods on an osteological board. The mean stature of the male Whites corresponded closely to values obtained for other large series of the living. The female White cadaver stature averaged 1 cm less than those of selected studies on living White females. The statures of both groups averaged about 8.5 cm taller than for Pearson's series. The Negro series averaged from 4 to 6 cm greater in their stature as compared to the figures cited for several large Negro populations.

Stature and long bone length means are reported for the 4 series studied. Pearson's means are presented for comparison. The correlations between stature and long bones and the intercorrelations between the long bones were determined, and from them, using Pearson's method, based on the theory of regression, new formulae were computed. For the most part, it was found that estimation of stature is less reliable from only one long bone than from a combination of two or more. The long bones of the lower extremity give a closer estimate than do those of the upper. These findings parallel those of Pearson.

As would be expected each of the formulae give the best results when applied to the population from which it is constructed. Pearson's formulae based on a population of relatively short stature appear to be adequate for assessing living heights of peoples with short limb bones. More accurate results for the longer limb bones are obtained from our formulae calculated from data of our taller population. Consequently the need for general formulae applicable to greater range of long bone lengths became apparent. By combining values derived from Pearson's and our population general formulae were developed which gave comparatively low mean deviations from known statures for certain selected populations.

It is thus suggested that the general rule for the use of formulae in a particular situation be that when the long bone is shorter than Pearson's mean for the bone, his formula be used; when it is longer than our mean, ours be used; and when it falls between these means, the general formula be employed.

If the race is unknown, the general formula is preferred. The Negro formulae should be used only for bones known to be of that race. When sex is in doubt, the length of the bone should determine which formula should be used. If it is closer to the male mean, use the male formula.

Application of these several formulae to the anthropological specimens cited by Pearson raises the question of the correct estimate of living stature for ancient man. In every instance our White formulae indicate taller statures than those calculated by Pearson. The results from the general formulae fall in an intermediate position. The conclusion is that the stature of early man cannot be estimated from any one set of formulae but can be more accurately predicted by employing that formula which was derived from bones of comparable dimensions.

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COLLECTION AND PRESERVATION OF SKELETONS.—In most temperate climates (including Greece) where bodies are buried in clayey soil one can expect no more than 5% to 15% of the burials to produce usable material. Even among these it will be impossible to preserve the ends of many long bones. Hence bone lengths should be measured accurately in the ground. It is wasted effort to collect fragments too incomplete for restoration, and proper discarding will save much time. As criteria for saving skeletons the general condition of the bones and lack of chemical dissolution are better than state of breakage. A skull broken into hundreds of fragments can be accurately restored and studied if every fragment is collected. Once he has decided to keep a given skeleton or skull the excavator must not overlook even the smallest bone fragments.

Probably the best technique for excavating a flexed or extended earth burial is to eschew over-careful cleaning after the initial plateauing and brushing, and to remove bones with a fair coating of earth. This applies particularly to the skull, which should be bedded down in earth for its trip to the field museum or preparation tent. After the bones have dried thoroughly in a shady place they should be carefully cleaned, washed if tough enough, and packed for shipping to the home base. It is not necessary to separate and label each region of any skeleton. With material buried in sand, or in mud and water, this whole process will be easier, since these conditions favor bone preservation.

The reader will notice an omission: "preservatives" such as Duco or Alvar solutions. The reason is that these are almost never usable in the field. Nothing has been more destructive to ancient skeletons than use of hot paraffine wax. This penetrates cracks in deteriorated bone and splits it like frost-heaves in a road: when one needs to remove paraffine from the surface and dissolve it out in order to glue together the fragments, the bone will simply disintegrate and require days of labor. This applies, less stringently, to other field preservatives, which weld dirt and bone together in a distorted mass. Skeletons over 7000 years old may be partial exceptions, since here more field care will be used in any case and cheese-soft fragments will be worth saving.

In order to harden a brittle bone after it has been cleaned in the home museum a good procedure is thorough impregnation with some toluene- or acetone-soluble plastic, such as polyvinyl acetate, which is itself adequately tough when dry. Air must be removed from the visible spongy interstices and microscopic canaliculi in order to allow the plastic solution to penetrate. Thorough soaking may be adequate, but impregnation under negative pressure is best. After they have dried, skull fragments are arranged in order on a table, like a Mercator projection of the globe. For skull-mending a slow-drying plastic, like one of the Alvars, is best, since this allows slight adjustments to be made for warping or wear as the whole skull is completed. Gaps should be left open or bridged if necessary by copper wire stiffened with a coat of plastic; plaster of Paris is generally too heavy and too wet. The necessity of restoring the sphenoid and other complex but key bones of the skull base demands a slight knowledge of anatomy, easily learnt by an intelligent person. . . — J. Lawrence Angel. *Skeletons*. *Archaeology*, vol. 3, no. 4 (12), December, 1950, pp. 233-241.

THE GROWTH AND DEVELOPMENTAL STATUS OF GUAMANIAN SCHOOL CHILDREN IN 1947

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SIX FIGURES

The observations reported in this paper are based on a study made in Guam in 1947 under the joint auspices of the Pacific Science Board of the National Research Council, the United States Navy, and the Viking Fund, of New York. It was part of a comprehensive anthropological survey of Micronesia officially designated the Coordinated Investigation of Micronesian Anthropology. The purpose of this part of the project was to determine the physical growth and developmental status of the Guamanian children, in order to ascertain the effects on them of the food deprivation and other hardships which they experienced during the Japanese occupation. It is planned to study a similar number of Guamanian children, after a period of years, in order to compare their physical status with that of the children examined in 1947. This comparison should make it possible to determine the effectiveness of the new school health and other public health measures that have been initiated on the island.

The study included 1800 children, 1726 of whom were between 6 and 17 years of age; 880 of these were boys and 846 were girls. The number of children of each age and sex studied is shown in table 1. They represented about 19% of the Guamanian children of school age living on the island at the time the study was made.

In selecting the villages from which the children were obtained for examination and study, an attempt was made to insure that all parts of the island would be represented pro-

portionately. This was done in order to obtain a reliable sample of the children and to detect any significant difference in their nutritional or developmental status that might be attributable to regional differences in diet in the various communities. The children studied were from the following villages: Agana, Mong Mong, Barrigada, Sinajana, Dededo, Talofofo, and Yona. The location of these villages and their position with reference to each other can be seen on the map of Guam, shown in figure 1.

TABLE 1
Number of children studied

AGE	NO. OF BOYS	NO. OF GIRLS
6	32	33
7	68	72
8	86	87
9	87	93
10	87	96
11	99	90
12	81	79
13	92	97
14	93	73
15	80	58
16	54	49
17	21	19
Total	880	846

Each child studied was measured and weighed, and an x-ray film of the hand and wrist was made in order to determine his developmental status and to obtain some information about the degree of mineralization of his skeleton.

A careful search of the literature failed to disclose any previous report on the height and weight of Guamanian children. The growth data which had been gathered by the Guamanian school officials during the years preceding the last war were destroyed during the shelling of the island. There is, therefore, no information available to us which would make it possible to compare the height and weight

of Guamanian children in 1947 with corresponding measurements made prior to the Second World War. The anthropometric data obtained in 1947 have, accordingly, been compared with those derived from the study of a selected group of White children who were enrolled in the Brush



Postwar Guam, 1946

Fig. 1 Map of Guam. Reproduced from Laura Thompson's *Guam and its People*, Princeton University Press, 1947. (Mong Mong is not shown on this map nor on any other to which the author had access. It is between Agaña and Barrigada.)

Foundation Study of Growth and Development, which was recently completed at Western Reserve University School of Medicine, in Cleveland, Ohio.

Average standing height

In table 2 are listed the average standing heights of the Guamanian boys and the Guamanian girls at each age from 6 to 17 years. The corresponding values based on the measurements of the children in the Cleveland Study are shown

TABLE 2
Average standing height (in centimeters)

AGES	BOYS		GIRLS	
	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)
6	107.1	117.7	106.5	117.6
7	111.8	123.8	111.5	123.8
8	116.9	129.9	116.5	129.8
9	120.4	135.4	120.9	135.3
10	125.1	141.0	126.4	141.0
11	130.1	145.9	132.0	147.7
12	133.4	151.4	136.6	154.2
13	139.2	157.5	143.3	159.5
14	143.5	164.8	147.7	162.9
15	149.4	171.1	150.9	164.8
16	155.1	175.2	151.5	165.5
17	159.3	176.6	150.9	165.4

in parallel columns of the same table. In figure 2, those data are presented graphically.

The absolute differences in average stature between the Guamanian and the Cleveland children throughout the age period studied are probably chiefly racial in origin, but they are due in part, also, to differences in the nutritional and health status of the two groups. The children in the Brush Foundation Study were carefully selected from families who were well above the average economic level of the Cleveland population. Their superior nutritional and health status is

attested by the fact that, throughout the period from infancy to adolescence, their average height and weight were significantly greater than those of the average child population of the United States.

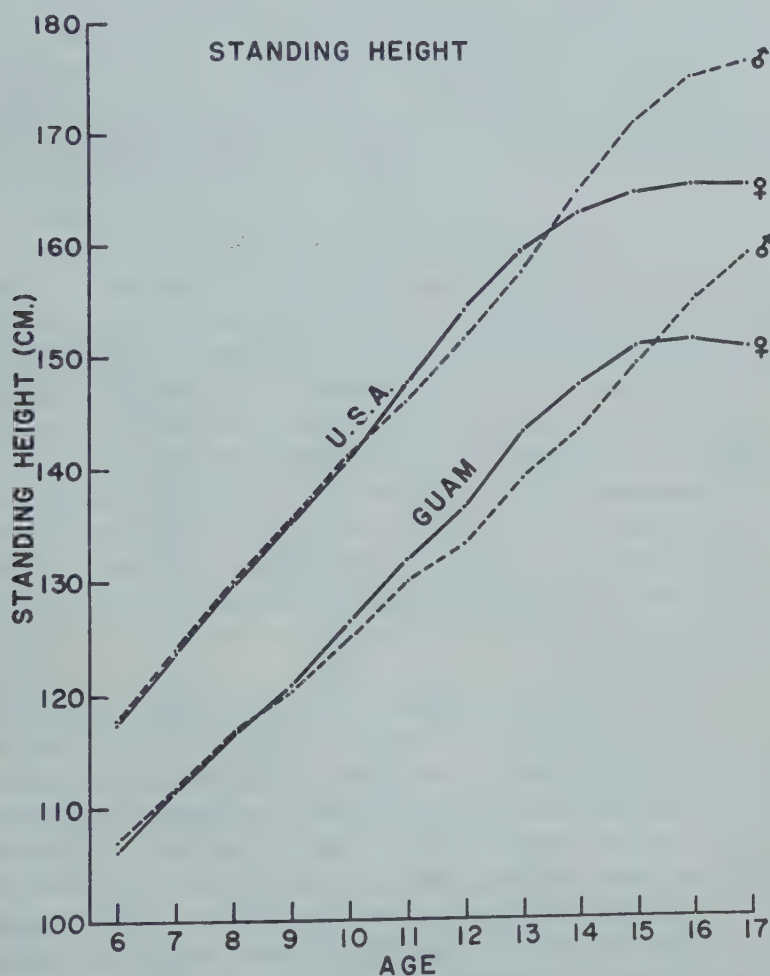


Fig. 2 Growth in standing height, Guamanian and Cleveland children.

Despite marked differences in average stature between the Guamanian and the Cleveland children, there is a close resemblance in the shape of the growth curves of those of the same sex in the two groups, the growth curves of the girls

being especially similar. There are some differences, however, in the age at which certain changes in the shape of the growth curves occur.

In the Cleveland girls, for example, the prepuberal spurt of growth in height begins between 10 and 11 years of age, while that of the Guamanian girls does not get under way until about one year later. The postpuberal deceleration in growth, which is evidenced by a beginning flattening of the growth curve, began in the Cleveland girls between 13 and 14 years, at least one year earlier than the beginning of the same process in the Guamanian girls. Growth in height in both groups of girls had practically ceased by age 16.

The average height of the Cleveland boys began to exceed that of the girls between 13 and 14 years, but the average height of the Guamanian boys remained less than that of the girls until between 15 and 16 years. The maximum annual average increment in stature occurred between 13 and 14 years in the Cleveland boys and between 14 and 15 years in the Guamanian boys. In the former, the rate of growth began to decelerate between 15 and 16 years and was further reduced during the following year. The Guamanian boys, however, were still growing rapidly between 16 and 17 and they probably continued to increase in stature for a year or more thereafter.

The growth of the Guamanian boys was somewhat retarded as compared with that of the girls of the same population. One indication of that retardation is the relatively long period—from about age 9 to 15 years—during which their average stature was less than that of the girls. The corresponding stage in the growth of the Cleveland children was limited to the three-year period from $10\frac{1}{2}$ to $13\frac{1}{2}$ years of age. While this might be partly a racial peculiarity of the Guamanians, it seems more probable that it is an indication of the greater vulnerability of the Guamanian boys, as compared with the girls, to the unfavorable environmental conditions to which they had been subjected. Further evidence bearing on this point will be presented later in this paper.

Average weight

In table 3 the average weights of the Guamanian and of the Cleveland children are listed separately for each age and sex. The corresponding weight curves are shown in figure 3.

It is apparent from both the table and the graph that the average weight of the Guamanian children is distinctly less than that of the Cleveland group throughout the entire age range considered in the study. The difference in weight is greatest in the case of the Guamanian boys during the period

TABLE 3
Average weight (in kilograms)

AGES	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)
6	18.1	21.9	17.4	21.9
7	19.6	24.6	19.0	24.7
8	21.5	28.0	21.0	28.1
9	22.9	31.0	23.1	31.6
10	25.2	34.9	25.6	35.4
11	28.4	38.8	30.1	40.1
12	30.2	43.2	32.9	45.6
13	33.7	47.9	37.9	50.1
14	36.7	54.0	40.8	54.5
15	41.6	60.0	45.9	57.4
16	46.4	64.4	46.0	58.9
17	49.9	66.9	47.4	60.9

from 12 to 15 years, when their weight as compared with that of the Cleveland males is relatively lower than at any other time.

The period during which the Guamanian boys weigh less than the Guamanian girls of the same age is about one year longer than the corresponding stage in the growth of the Cleveland children. The average weight of the Guamanian boys does not begin to exceed that of the girls until they are about 16 years of age. Among the Cleveland children, however, that same change occurs when they are between 14 and 15 years old.

These weight data, too, appear to support the assumption that the growth of the Guamanian boys had been more adversely affected than that of the Guamanian girls by the hardships which they had undergone.

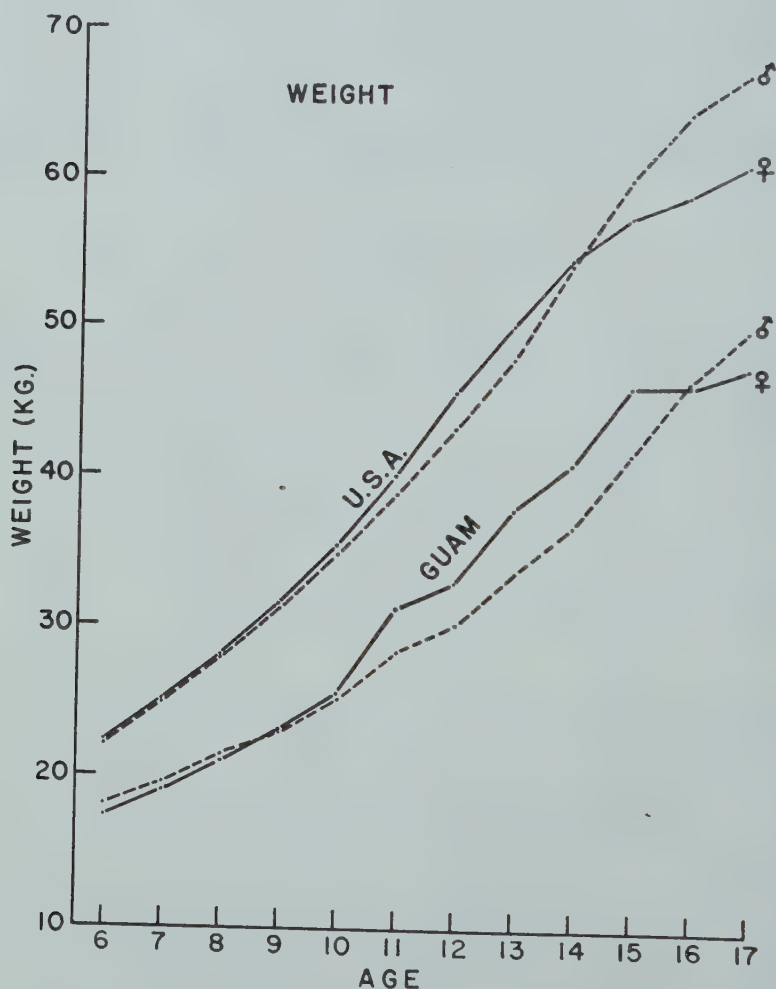


Fig. 3 Growth in weight, Guamanian and Cleveland children.

Skeletal age

The average skeletal ages of the Guamanian boys and girls are shown in table 4 and in figure 4. The skeletal ages were

determined by assessing x-ray films of their hands and wrists by means of the Greulich-Pyle x-ray standards (Greulich and Pyle, '50). These Standards are based on the rate at which skeletal development proceeded in the same Cleveland boys and girls whose average heights and weights were used in evaluating the other physical growth data of the Guamanian children. The skeletal age assigned to each of the series of radiographs comprising the Greulich-Pyle Standards is the same as the modal chronological age (age in years) of the Cleveland children when they attained the stage of skeletal development

TABLE 4
Average skeletal age of Guamanian children

CHRONOLOGICAL AGE	SKELETAL AGE	
	BOYS	GIRLS
6	5.1	4.9
7	5.7	5.7
8	6.3	6.4
9	6.9	7.3
10	7.5	8.2
11	9.0	9.8
12	9.6	10.8
13	11.1	12.4
14	11.8	13.3
15	13.4	14.5
16	14.5	15.2
17	16.0	16.2

depicted in that film. Consequently, each year of skeletal age corresponds to one year of chronological age in the Standards. The latter are represented in figure 4 by a diagonal line.

It will be noted that the skeletal age of both the Guamanian girls and the Guamanian boys is less than that of the Cleveland children at every age at which observations were made. As in the case of both height and weight, the skeletal development of the boys was more retarded than that of the girls at all except the youngest ages. Using the method of Palmer ('34) in evaluating the statistical significance of the difference between the mean skeletal ages of the Guamanian

boys and girls, it was found that the skeletal ages of the girls over the age span studied were significantly higher than those of the boys ($P=0.0001$, i.e., there is less than one chance in 10,000 that such a series of differences in skeletal age would be due to chance alone).

The consistently greater retardation in skeletal development of the Guamanian boys as compared with the girls is

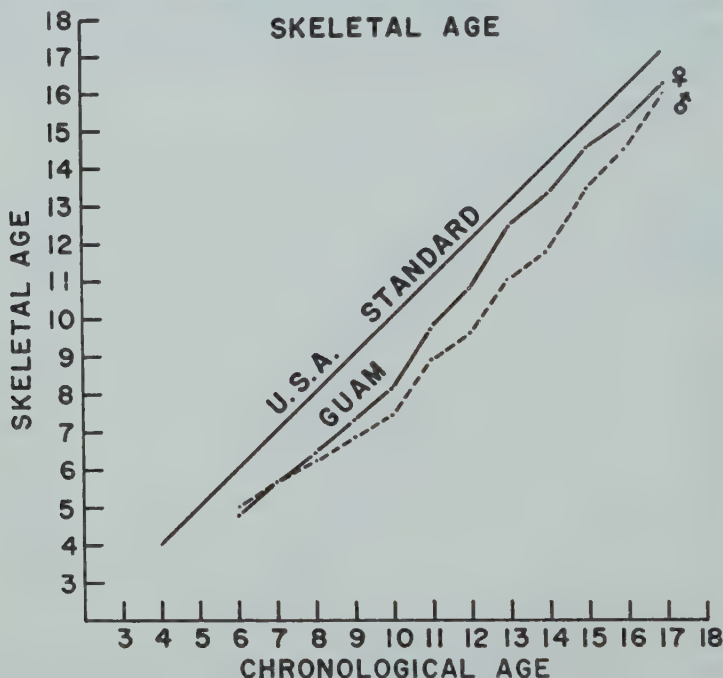


Fig. 4 Skeletal vs. chronological age.

further evidence of their relatively inferior physical status. This interpretation is supported, also, by a comparison of their height-weight indexes and their sitting heights.

Height-weight index

The height-weight index, $\frac{\text{Weight in grams}}{\text{Height in centimeters}}$, though a somewhat arbitrary device, is useful for comparing the weight per unit height of individuals. In the case of children, espe-

cially children of the same racial group, it can also help to distinguish those who are well nourished from those who are significantly underweight.

In table 5 and figure 5 one may compare the height-weight indexes of the Cleveland and the Guamanian children. From the information available to us, it is not possible to determine how much of the difference between the height-weight in-

TABLE 5

Height-weight index (weight in grams divided by height in centimeters)

AGE	BOYS		GIRLS	
	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)
6	169.2	185.8	162.9	186.1
7	175.4	198.7	170.5	199.6
8	183.6	215.2	180.5	216.3
9	190.2	229.2	191.1	233.3
10	201.2	247.2	202.2	251.2
11	218.1	266.1	228.3	271.5
12	226.3	285.1	240.8	295.5
13	241.8	304.3	264.1	314.1
14	255.7	327.7	276.5	334.6
15	278.4	350.6	304.2	348.5
16	299.5	367.4	303.3	355.8
17	313.6	379.0	313.7	368.4

dexes of the two groups is racial in origin and how much is due to the superior nutritional status of the White children. It should be noted, however, that from about 11 to 16 years of age the height-weight index of the Guamanian boys is especially low. During that period, the difference between it and that of the Guamanian girls is distinctly greater than the corresponding sexual difference among the Cleveland children.

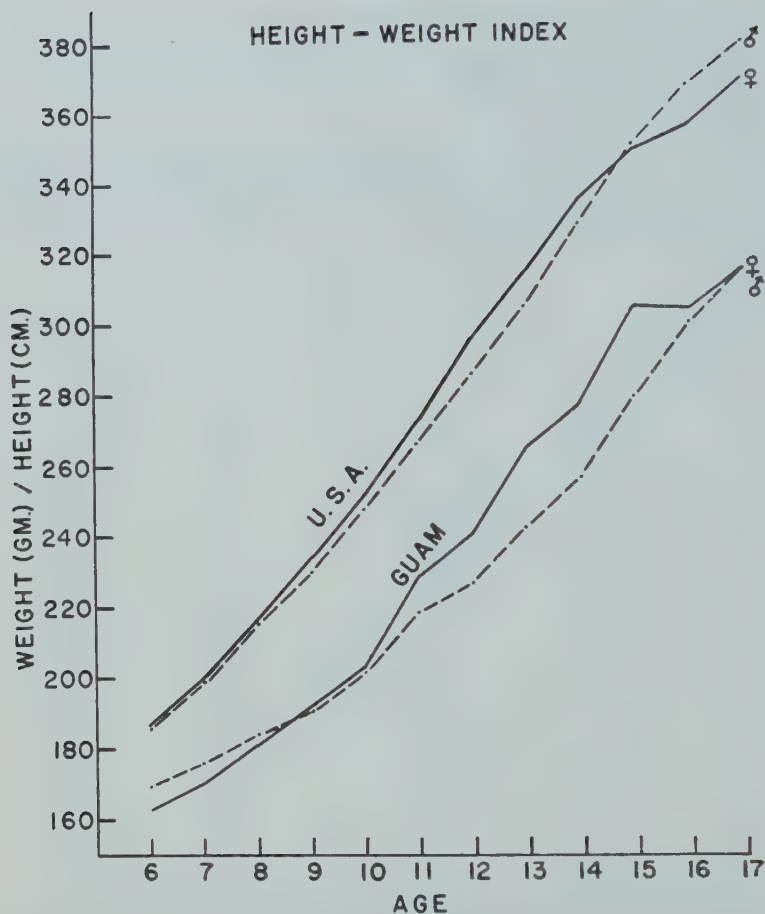


Fig. 5 Increase in height-weight index, Guamanian and Cleveland children.

Sitting height

Further evidence of the relatively retarded growth rate of the Guamanian boys is provided by the data on sitting height in table 6 and figure 6. The average sitting height of girls usually begins to exceed that of the boys of the same population at about 11 years of age and it remains greater until they are about 15. The Cleveland children conform to this pattern and, if one can judge from the similarity in the shape of the curves of sitting height of the Cleveland and the Guama-

nian girls, so do the latter. The Guamanian boys, however, are decidedly atypical in this respect. Their average sitting height is less than that of the Guamanian girls at each age from about 9 to 16 years—a period almost twice as long as the usual one. This deficit in trunk length is yet another indication of their general growth retardation.

In order to facilitate comparison, the average standing height, the average sitting height, the average weight, and the range of each of these measurements of the Guamanian children were arranged in tabular form. In 12 of the tables

TABLE 6
Average sitting height (in centimeters)

AGES	BOYS		GIRLS	
	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)	GUAM 1947	U.S.A. (BRUSH FOUNDATION STUDY)
6	59.9	65.4	59.1	65.1
7	62.3	67.7	61.7	67.5
8	64.1	70.3	63.9	69.8
9	65.6	72.4	65.9	71.9
10	67.3	74.3	68.1	74.2
11	69.7	76.2	70.8	76.9
12	70.8	78.3	73.0	80.1
13	73.3	80.9	76.4	83.6
14	75.2	84.6	78.8	86.1
15	78.3	88.6	80.4	87.3
16	81.1	90.4	81.2	87.9
17	83.6	91.8	80.3	88.0

these anthropometric data are listed separately for each sex and for each successive age group from 6 to 17 years. In 7 other tables the same data are regrouped so as to show, separately for each village, the average measurements of all its children who were included in the study. The tables enable one to compare children of the same age from the various villages or all the children of one village with those of another. Since it was not feasible to include so much tabular material in this paper, mimeographed copies of the tables have been prepared and can be obtained from the author.

An analysis of the anthropometric and x-ray data did not disclose any significant difference in growth and developmental status between the children of the various villages. In this respect, no one group of children was consistently

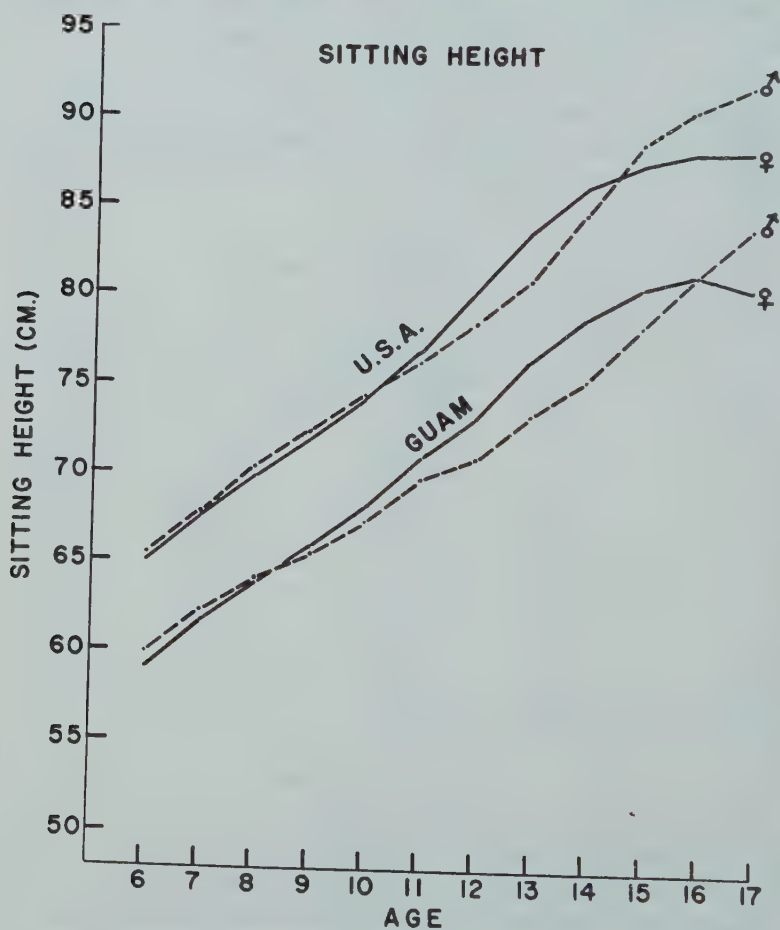


Fig. 6 Growth in sitting height, Guamanian and Cleveland children.

superior or inferior to any other. The general physical retardation of the boys as compared with the girls, to which attention was directed earlier in this report, is, however, confirmed by the data in the tables.

SUMMARY

An anthropometric and x-ray study of a representative group of children in Guam in 1947 disclosed that they were significantly retarded in standing height, sitting height, weight, and in their skeletal development as compared with a group of well-circumstanced White children of the same age in the United States. It is believed that the relative physical retardation of the Guamanian, as compared with the White, children is due only in part to racial differences in the two groups and that some, perhaps much of it, is attributable to the food deprivation and other hardships which they experienced during the war, especially during the period of the Japanese occupation of the island. The Guamanian boys were found to be relatively more retarded than the girls in growth and in skeletal status. This is consistent with the view that the human male is less successful than the female in withstanding the rigors of an unfavorable environment.

The author wishes gratefully to acknowledge his indebtedness to his wife, Mildred L. Greulich, who assisted in the anthropometric work in Guam and who learned with him that the pleasure of dealing with Guamanian children and their parents far outweighs the discomforts of a hot and humid Guamanian summer. He is grateful, too, to Dr. Cathrine S. Crismon and Mrs. Margaret L. Turner for their invaluable help in the task of processing and interpreting the data.

This study would not have been possible without the generous cooperation of the officials of the Naval Government of Guam in 1947. Their kindness in making available the x-ray and other facilities required for the work and their gracious hospitality throughout the period of our residence on the island contributed much to the success of the project and placed us permanently in their debt.

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SUTURE CLOSURE IN AUSTRALIANS.—The vault of the skull is separated from the base by what is — particularly in the Australian aborigine — a virtually horizontal suture complex . . . comprising the fronto-nasals, the zygomatico-frontals, the speno-frontals, and speno-temporals (where this sequence exists), the squamo-parietals, masto-parietals, and the lambdoid. This complex may well be called “the great horizontal suture.” As opposed to this are the sutures of the vault — metopic, coronal and sagittal on the one hand; . . . and the joints of the base — speno-occipital, temporo-sphenoid and masto-occipital on the other. . . . Of the three basal joints the speno-occipital is wholly between cartilage bones, the masto-occipital mainly so, and the temporo-sphenoid partly so. The articulations of the vault and base close appreciably earlier than the members of the great horizontal suture, both in the Todd and Lyon series and in this. Exceptions are found where the systems meet at the pterion and lambda. In addition, the great horizontal suture is notable for the presence of a number of fontanelles, and it is the major site for Wormian bones which are, incidentally, especially common at the pterion, asterion and lambda.

It is interesting to note that the main difference between the patterns [of closure in Europeans and Australian aborigines] concerns the vault much more than the base or the great horizontal suture. This last, indeed, can scarcely be distinguished in the two groups. Altogether, even allowing for the fact that the criteria for comparison are not quite the same, it is not unreasonable to assume that in many aboriginal skulls joint closure is not so decidedly different from that in Europeans as is usually supposed.— A. A. Abbie. Closure of cranial articulations in the skull of the Australian aborigine. *J. Anat.*, vol. 84, pt. 1, January, 1950, pp. 1-12.

BLOOD TYPES OF NATIVES OF AUSTRALIA AND NEW GUINEA

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Simmons, Graydon and their co-workers ('44, '44a, '45, '46 and '48) have published several papers relating to the ABO, MN and Rh blood groups of Australian aborigines and Papuans. The purpose of this paper is to give further results of blood group tests on these people. The samples, sent by air in the form of clotted blood, were tested two days after they were taken; all appeared to be in excellent condition.

The samples were tested for the A₁ A₂ B O, MNS, Rh, P, Lewis, Kell and Lutheran groups. The results of the MNS tests on these people have already been published by Sanger ('50).

Australian aborigines

The 178 aborigines tested were from Bathurst Island in Northern Territory, and from Cherbourg and Woorabinda in Queensland; they were unrelated and allegedly full-blooded. The A₁ A₂ B O groups are given in table 1, the MNS groups in table 2, the Rh groups in table 3. In calculating the frequencies of all these groups the Bathurst Island aborigines have been treated separately from the Cherbourg and Woorabinda aborigines, partly because of their geographical situation and partly because aborigines from the latter two districts possess antigens and combinations of antigens not present in the 98 Bathurst Islanders.

The methods used for calculating the gene frequencies and the expected numbers of people which should belong to each group are standard ones (Race and Sanger, '50). The χ^2

has been given in those cases where the agreement between the expected and observed results is not extremely close.

Table 1, which gives the $A_1 A_2 B O$ groups of the aborigines, shows that the gene B is present in the Queensland aborigines while it is absent from the Bathurst Islanders. No examples of A_2 or $A_2 B$ blood groups were found in the 178 samples.

The MNS groups of the aborigines are interesting (table 2) since the S antigen is absent from all the aborigines tested. This is the first race of people yet tested in which the S

TABLE 1

*The $A_1 A_2 B O$ groups of 178 Australian aborigines
(as defined by anti- A_1 , anti-B, and anti- A_1)*

	BATHURST ISLAND			CHERBOURG AND WOORABINDA				
	Obs. abs.	Obs. frequency	Exp. abs.	C. Obs. abs.	W. Obs. abs.	Total obs.	Obs. frequency	Exp. abs.
O	72	0.7347	72.0	15	31	46	0.5750	46.0
A_1	26	0.2653	26.0	13	16	29	0.3625	28.9
B	..	.....	...	1	3	4	0.0500	3.9
$A_1 B$	..	.....	...	1	0	1	0.0125	1.1
Totals	98	1.0000	98.0	30	50	80	1.0000	79.9
Gene frequencies				Gene frequencies				
O = 0.8571				O = 0.7587				
A_1 = 0.1429				A_1 = 0.2095				
B = 0.0000				B = 0.0318				

antigen is not to be found; in England 54.69% of people possess the antigen. (Race and Sanger, '50.)

The Rh groups are shown in table 3. The chromosomes cde (r), C^wDe (R_1^w), cdE (R''), Cde (R'), and CdE (R_y) were not identified in the aborigines. The chromosome CDE (R_z) found in the Queensland aborigines was not present in the 98 Bathurst Islanders.

Three of the samples from Bathurst Island and one from Woorabinda gave evidence of a further allelomorph at the E locus. A third allelomorph E^u has already been described

by Ceppellini, Ikin and Mourant ('50). In these aborigines the E variant was noticed when the samples gave a positive reaction with one anti-E serum and a negative (or, in two cases, extremely weak) reaction with another powerful anti-E. All samples gave positive indirect anti-globulin tests with the latter anti-E which was from a CDe/CDe patient and therefore contained no incomplete anti-D. A fresh sample from the Woorabinda aborigine gave the same results with

TABLE 2
The MNS groups of 178 Australian aborigines
(defined by anti-M, anti-N and anti-S)

	BATHURST ISLAND			CHERBOURG AND WOORABINDA				
	Obs. abs.	Obs. frequency	Exp. abs.	C. Obs. abs.	W. Obs. abs.	Total obs.	Obs. frequency	Exp. abs.
MM. S	..	.....	...	..	..	..	.....	...
MsMs	10	0.1020	6.9	2	2	4	0.0500	4.8
MN. S	..	.....	...	..	..	..	.....	...
MsNs	32	0.3265	38.2	10	21	31	0.3875	29.5
NN. S	..	.....	...	..	..	..	.....	...
NsNs	56	0.5714	52.9	18	27	45	0.5625	45.8
Totals	98	0.9999	98.0	30	50	80	1.0000	80.1
Gene frequencies				Gene frequencies				
Ms, 0.2653				Ms, 0.2437				
Ns, 0.7347				Ns, 0.7563				
$\chi^2 = 2.57$ for 1 d.f.				$\chi^2 = 0.21$ for 1 d.f.				

these anti-E sera. The variant of the E antigen has been counted as a normal E antigen in the calculation.

The aborigines were also tested for the Lutheran groups but no Lutheran positive bloods were found.

The Lewis antiserum, anti-Le^a, was also used and although Le(a+) bloods were clearly present it seems unwise to report the frequency since the antibody, a cold agglutinin, is only reliable when used against fresh cells.

Only the 98 Bathurst Islanders were tested for the P groups. The two anti-P sera used were weak cold agglutinins; they

gave identical and good positive reactions with 34.7% of the bloods, and negative-reactions with 65.3%. Some, perhaps all, of the apparent P negative samples may in fact be weak P positives; for samples sent on an experimental journey, more rigorous than that endured by these samples, gave only weak positives and some false negatives with these anti-P sera. Nevertheless it is clear that the aborigines do not, as for

TABLE 3
The Rh groups of 178 Australian aborigines
(defined by anti-C-c-C^w-D-E-and e)

	BATHURST ISLAND			CHERBOURG AND WOORABINDA				
	Obs. abs.	Obs. frequency	Exp. abs.	C. Obs. abs.	W. Obs. abs.	Total obs. abs.	Obs. frequency	Exp. abs.
CDe/CDe (R ₁ R ₁)	42	0.4286	39.9	9	29	38	0.4750	36.4
CDe/cDe (R ₁ R ₀)	33	0.3367	35.7	5	6	11	0.1375	14.2
CDe/cDE (R ₁ R ₂)	8	0.0816	9.6	10	4	14	0.1750	13.8
cDE/cDE (R ₂ R ₂)	0	0.0000	0.6	0	1	1	0.0125	1.0
cDE/cDe (R ₂ R ₀)	7	0.0714	4.3	1	3	4	0.0500	2.4
cDe/cDe (R ₀ R ₀)	8	0.0816	8.0	1	1	2	0.0250	1.4
CDe/CDE (R ₁ R ₂)	..	.....	..	4	5	9	0.1125	8.8
CDE/CDE (R ₂ R ₂)	..	.....	..	0	1	1	0.0125	0.5
cDE/CDE (R ₂ R ₂)	..	.....	..	0	0	0	0.0000	1.5
Totals	98	0.9999	98.1	30	50	80	1.0000	80.0
Rh chromosome frequencies				Rh chromosome frequencies				
CDe (R ₁)	0.6378			CDe (R ₁)	0.6747			
cDe (R ₀)	0.2857			cDe (R ₀)	0.1315			
cDE (R ₂)	0.0765			cDE (R ₂)	0.1122			
CDE (R ₂)	.....			CDE (R ₂)	0.0816			

example do the American negroes (Wiener and Unger, '44), contain a high proportion of strong P + bloods.

Again, only the Bathurst Island aborigines were tested for the Kell groups, and no K + bloods were found, but at this stage it was realized that the anti-K used would not give positive reactions with known K + bloods after they had been sent for a three day air trip, though the serum was perfectly reliable with fresh cells. On the other hand S

positive and Lutheran positive samples sent on the trip gave good reactions on their return.

New Guinea natives

Blood samples from the New Guinea natives, collected at a hospital in Port Moresby, were from 16 different districts; 61 were from Kerema, 13 from Daru, 6 from Kairuku, 12 from Port Moresby, 2 from Higaturu, 2 from Samarai, 2 from Ioma, 4 from Rigo, 3 from Abau, 4 from Baniara, 11 from Misima, 4 from Esaala, 5 from Madang, 4 from Aitape, 4 from Ra-

TABLE 4

*The $A_1 A_2 B O$ blood groups of 141 New Guinea natives
(defined by anti- A , anti- B and anti- A_1)*

	OBSERVED ABSOLUTE	OBSERVED FREQUENCY	EXPECTED ABSOLUTE
O	58	0.4113	57.2
A_1	53	0.3759	53.9
B	21	0.1489	22.0
$A_1 B$	9	0.0638	8.0
Totals	141	0.9999	141.1

Gene frequencies

O	0.6367
A_1	0.2508
B	0.1125

bau, and 4 from Bougainville. Although natives of some of these districts are known to differ anthropologically we have pooled the results since the numbers from each place are for the most part very small.

The $A_1 A_2 B O$ groups, given in table 4, show a marked difference in frequencies from the Australian aborigines, although again no examples of A_2 or $A_2 B$ bloods were found.

The MNS groups are shown in table 5. The S antigen is present in 22.7% of these people. It can be calculated that 26% of the M genes are MS and 10.5% of the N genes are

NS. This ratio of MS to NS of 2.5 to 1 is close to that found in England, viz., 2.8 to 1.

The Rh groups are given in table 6. The frequencies are very different from those found in the Australian aborigines.

TABLE 5

*The MNS groups of 141 New Guinea natives
(defined by anti-M, anti-N and anti-S)*

	OBSERVED ABSOLUTE	OBSERVED FREQUENCY	EXPECTED ABSOLUTE
M. S	1	0.0071	2.6
MsMs	7	0.0496	3.1
MN. S	13	0.0922	15.3
MsNs	30	0.2128	30.0
N. S	18	0.1277	18.0
NsNs	72	0.5106	72.0
Totals	141	1.0000	141.0

Gene frequencies

MS	0.0522
Ms	0.1489
NS	0.0843
Ns	0.7146

TABLE 6

*The Rh group of 141 New Guinea natives
(defined by anti-C-c-C^w-D-E and -e)*

	OBSERVED ABSOLUTE	OBSERVED FREQUENCY	EXPECTED ABSOLUTE
CDe/CDe ($R_1 R_1$)	127	0.9007	127.37
CDe/cDE ($R_1 R_2$)	12	0.0851	11.39
CDe/cDe ($R_1 R_0$)	2	0.0142	1.90
cDE/cDE ($R_2 R_2$)	0	0.0000	0.25
cDE/cDe ($R_2 R_0$)	0	0.0000	0.08
cDe/cDe ($R_0 R_0$)	0	0.0000	0.01
Totals	141	1.0000	141.00

Rh chromosome frequencies

CDe (R_1)	0.9504
cDE (R_2)	0.0425
cDe (R_0)	0.0071

The chromosomes cde (r), C^wDe (R_1^w), cdE (R''), Cde (R'), CDE (R_z) and CdE (R_y) were not identified in the New Guinea natives.

There were no Lutheran positive samples found among these people.

All the samples were tested for the Lewis, P and Kell groups, but the lability of these antigens has already been mentioned and the results are probably not reliable. Lewis positive bloods were clearly present; 44% of the bloods were grouped as P —, but these very probably include many weak P + bloods; no K + bloods were found.

SUMMARY

The A_1 , A_2 , B O, MNS, Rh and Lutheran groups of 178 Australian aborigines and 141 New Guinea natives are given, together with remarks on the Kell, Lewis and P groups.

That the Lutheran antigen (Lu^a) was not encountered in either of these relatively small samples does not of course prove that the Lu^a antigen cannot exist in these people; but the figures are at any rate large enough to show a significant difference from the European distribution.

In the Rh groups of the Australian aborigines there is evidence of a variant at the E locus.

Perhaps the most interesting result of this investigation is that the anti-S serum, which subdivides the MN groups, makes a very sharp distinction between Australian aborigines and New Guinea natives, while anti-M and anti-N alone show but little difference between these two anthropologically distinct groups.

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SULCAL PATTERN ON ENDOCRANIAL CASTS.—A comparison of an endocranial cast with the corresponding brain is the obvious method of determining how much accurate information about the brain can be obtained from the cast. . . .

. . . No direct comparison of cast with corresponding brain [in an Australian aborigine] has been published. Therefore, it seemed of value to make such a comparison, in order partly to bridge the gap between Symington's findings for the European and those of LeGros Clark et al. for the chimpanzee. . . .

The brain/endocranial cast studies on primates so far made all show the difficulty of correctly inferring the sulcal pattern from the cast markings, even in those regions where there are well-marked grooves. It seems probable, therefore, that the interpretation of the sulcal pattern on endocranial casts from fossil skulls is likewise liable to error. It is suggested that such casts might well be restudied after an extensive preliminary comparison of brain and endocranial cast in living primates.—A. D. Packer. A comparison of endocranial cast and brain of an Australian aborigine. *J. Anat.*, vol. 83, pt. 3, July, 1949, pp. 195–204.

QUESTIONS RELATING TO A NEW LARGE ANTHROPOID APE FROM THE MIO-PLIOCENE OF THE SIWALIKS

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ONE FIGURE

In 1915, Pilgrim described at some length an isolated, slightly worn right P_3 of a large anthropoid originating from Haritalyangar, Simla Hills, Bilaspur State, in the Punjab, and found in beds probably representing the Nagri zone of the Siwaliks, then supposed to be Upper Miocene in age. The specimen, identified as *Sivapithecus* cf. *indicus* Pilgrim, is in the collection of the Indian Museum at Calcutta (no. DL. 190); the American Museum of Natural History has two plaster casts.

Pilgrim ('15, p. 45) first pointed out that the posterior contact facet and the presence of the outer portion of the alveolus of the C still preserved on the specimen at the antero-internal margin prove the correct orientation of the tooth in the mandibular ramus. Thus placed, the metaconid ridge is approximately transverse in its course. The contour of the crown and the position of the cusps, ridges, and fossae are carefully noted, and three views of the specimen are presented (loc. cit., plate 1, figs. 9, 9a, b). The description can be restated somewhat as follows:

The tooth is subtriangular in outline with a very convex outer surface on which the enamel anteriorly is much produced toward the root. The outer surface passes backward gradually, without any abrupt change in the contour, into the straight hinder wall. The inner wall of the tooth forms a very acute angle with the hinder wall and proceeds obliquely

toward the outside, where it forms an equally abrupt angle with the outer wall of the tooth, only in this case the angle is a right angle. Thus the actual front wall of the tooth is reduced to the width of a narrow ridge.

The main cusp or protoconid is situated in the center of the tooth, and from it three ridges run down, an anterior, a transverse, and a posterior one. The anterior ridge runs from the tip of the protoconid directly forward to the front point of the tooth. The transverse ridge connects the protoconid with a faint secondary cusp (metaconid) directly internal to it, and continues, curving backward, until it joins the posterior marginal ridge of the crown. The ridge descending backward from the protoconid is first straight, then curves inward and joins the posterior marginal ridge also.

On its anterior side, the transverse or metaconid ridge falls abruptly into a small hollow just internal to the ridge running forward from the protoconid; the trigonid fossa. This fossa is bounded below by the inner cingulum which runs backward from the base of the anterior ridge along the lingual surface and rises into a point at the base of the metaconid ridge. On its hinder side the transverse ridge falls equally abruptly into a hollow, bounded by the posterior ridge and the raised posterior edge of the tooth—the talonid fossa. A slight cingulum may be present externally, but in any case it is obliterated in the present instance by a strong area of wear at the antero-external corner of the tooth. At this corner the enamel is protruded downward; the gingival border of the enamel is distinctly convex toward the root whereas it is concave toward the root below the base of the posterior ridge from the protoconid tip and along the whole of the lingual surface of the crown.

There is an anterior root, compressed transversely and placed below the prominent antero-external angle of the crown just buccally of the alveolus of the canine, while posteriorly there is a broad root, compressed antero-posteriorly.

In the above description I have followed Pilgrim's as closely as possible as far as the outline, ridges and hollows

are concerned, having been only more elaborate on the cingulum and the course of the gingival border of the enamel, and introducing the now-usual Osbornian nomenclature. The reason why I have given new illustrations of the tooth is that Pilgrim's figures do not show very well one of the most important characters of the tooth, viz., the antero-external enamel protrusion of crown which gives this tooth its typically anthropoid sectorial character. In the "external side" view (Pilgrim, '15, pl. 1, fig. 9a, better: antero-external view) the crown appears to be much more nearly symmetrical than it is in reality, the bulging out of the enamel border at the lower right hand side of the figure being not sufficiently pronounced. And in the crown view (Pilgrim, fig. 9), though this is correct in most details, the postero-internal angle of the crown is drawn a little too sharp, and the external surface appears to be straight and even slightly concave in part, while in reality this surface is convex from side to side. Finally the "back view" (Pilgrim, loc. cit., fig. 9 b; better: buccal view) is reasonably good and shows the sectorial character of the tooth very nicely.

In my opinion there is virtually nothing — no character at all — by which the present tooth can be distinguished from the P_3 of the common orangutan.

However, Pilgrim remarks that the present fossil tooth differs from the P_3 in gorilla and orangutan in (a) its much greater transverse diameter and corresponding diminution in length, and (b) the bicuspid character of the transverse ridge. We shall consider these points below first.

The measurements given by Pilgrim ('15, p. 71) are: length 12.8 mm, width 14.1 mm, and width-length index 110.1. In reality this index should be 110.2, but the last decimal place is not reliable. I give it because it is usually given in anthropological literature. In fact even the last digit before the decimal point is uncertain; the measurements are correct only to 0.05 mm, and this gives a possible variation in the index from 109.3 to 111.0. Pilgrim does not state how he took his measurements, but the cast shows that these

measurements were taken at right angles to each other with the metaconid ridge oriented so that it runs inward and backward from the protoconid at an angle of about 23° from the transverse line. In this orientation we have neither the greatest nor the smallest diameter of the crown.

In a later paper Pilgrim ('27, p. 16) refers the present tooth to *Sivapithecus himalayensis* Pilgrim and gives the transverse diameter again as 14.1 mm, but the antero-posterior diameter is now stated to be only 11.6 mm, which is the length of the crown when the metaconid ridge runs backward and inward from the protoconid at an angle of about 11° from the transverse line. The width-length index now becomes 121.6.

Remane ('22, p. 167) does not copy Pilgrim's measurements in his comparative study, but states that the index of the P_3 as given by Pilgrim (110.1) must have been taken in a way different from the others.

Gregory and Hellman ('26, p. 42) give 12.6 mm as the antero-posterior diameter and 9.7 mm as the transverse diameter, which makes the width-length index 77.0 (Gregory and Hellman, loc. cit., give 79.3). From the same casts I figure that the antero-posterior diameter was taken at an angle of about 110° on the metaconid ridge, or with the latter ridge running backward and inward at an angle of about 20° from the transverse line. This is only very slightly different from the way Pilgrim originally measured the specimen. What is given by Gregory and Hellman as the transverse diameter, however, is the diameter of the crown, not quite down to the base (in which case it would be 10.3 mm) taken at right angles to the long axis of the crown which latter runs from antero-buccal to postero-lingual. The transverse diameter as measured by Gregory and Hellman is consequently not at right angles to what is supposed to have been the antero-posterior line of the P_3 when in situ in the ramus. The width-length index of the tooth as given by Gregory and Hellman is very different from Pilgrim's figures. Gregory and Hellman also give the height of the crown as 10 mm, which is

the height of the protoconid above the lingual base of the crown, and the height index as 79.3, which must be their height $\times 100$ divided by the antero-posterior diameter.

Tooth indices are given great value in studies relating to the evolution of teeth and seemingly offer convenient means of comparison. In the present case Pilgrim, Gregory, Hellman and others relied on them for purposes of comparison. One must be sure, however (Gregory and Hellman, p. 32) to use only measurements which were made according to one and the same method. The above account shows sufficiently clearly that, in a case like this, i.e., a sub-oval or sub-triangular tooth that is placed with its long axis more or less oblique to the antero-posterior line of the toothrow, a slight rotation leads to great differences in the antero-posterior and transverse diameters.

The only correct method by which to measure such a tooth so as to be able to use the data for comparative studies is to take the greatest diameter of the crown, about which there can be no difference in opinion, and the diameter at right angles to the former. This is what I have done when measuring the orangutan P_3 's (Hooijer, '48, p. 221).

In table 1 the measurements and indices of the Haritalyangar tooth can be compared with those of a number of recent male and female P_3 's of the recent orangutan (loc. cit., table 2 B).

The antero-posterior diameter, measured along the long axis of the crown over the antero-external enamel protrusion and the postero-lingual angle, as well as the transverse diameter, taken at right angles to the latter, present no differences between the fossil tooth and the recent: the Haritalyangar tooth is well within the variation limits of the recent male and female orangutan P_3 's. The vertical diameter, the greatest height of the crown on the antero-buccal surface, is also within both the male and the female ranges but to the lower side of the former and to the higher side of the latter. The height index, for which I took the antero-posterior diameter $\times 100$ divided by the vertical diameter, falls within the

limits of that of the female P_3 only, and is above the observed range in the male P_3 . However, the difference proves to be not significant statistically. The present tooth might be slightly worn at the protoconid tip, though this is not clear from Pilgrim's figures and description or from the

TABLE 1

Measurements (mm) and indices of the Haritalyangar P_3 and that of male and female orangutan (recent)

	HARI-TALYANGAR	PONGO PYGMAEUS PYGMAEUS (HOPPIUS)			
		MALES		FEMALES	
		N	RANGE	N	RANGE
Antero-posterior	16.4	23	13.0-18.0	23	11.4-18.1
Transverse	10.3	25	8.3-12.6	22	8.0-11.3
Vertical	14.2	8	14.1-18.0	7	9.6-15.3
Height index	115.5	8	95.9-113.3	7	98.0-118.6

TABLE 2

Measurements (mm) and indices of the P_3 of Dryopithecus, Sivapithecus, and the Haritalyangar specimen

	DRYOPITHECUS			SIVA-PITHECUS HIMALA-YENSIS	HARI-TALYANGAR
	FONTANI	PILGRIMI	CAUTLEYI		
Antero-posterior (// protoconid ridges)	10.9	10.7	10.2	11.2	11.6
Transverse (\perp protoconid ridges)	9.5	9.2	9.3	11.2	15.1
Width-length index	87.2	86.0	91.2	100	130

casts; it is worn anyhow on the antero-external surface. If the height of the crown were slightly greater the height index would be smaller and well within both ranges.

The antero-posterior diameter as I take it is not influenced by wear because it is measured from the lowest point of the

antero-buccal enamel protrusion which is reached by wear from the upper canine only after prolonged wear.

The bicuspid character of the transverse ridge, the second difference between the fossil tooth and the orangutan P_3 noted by Pilgrim, is not more marked in the fossil than in the orang, in which a metaconid is often developed, and occasionally even stronger than in the fossil (Hooijer, '48, pl. 5, figs. 6, 7). Other, non-metrical characters, such as the shape and position of the ridges and fossae, do not enable us to distinguish the fossil from the recent P_3 of the orangutan either.

Remane ('22, p. 168), misled by Pilgrim's figures, writes that in outer view the Haritalyangar P_3 resembles many of its homologues in the chimpanzee "da der vordere Aussenteil seiner Krone sich nicht auf die Vorderwurzel herabzieht (primitives Merkmal)." This is incorrect, as we have seen above. In reality the anterior extension of the enamel on the buccal surface down to the root is as pronounced as it is in the orangutan. The distinctly marked-off metaconid is regarded by Remane as perhaps representing a primitive character. As already said, the orang occasionally develops the same metaconid on its P_3 . The subfossil P_3 of the orang from Sumatra, of which I was able to examine 270 specimens, unlike the recent (Remane, '22, p. 60) does sometimes have a hypoconid and an entoconid as well (Hooijer, '48, p. 221). Yet it does not seem to me that the subfossil or fossil orangutan has its primary and secondary cusps more clearly developed than has the recent.

Remane ('22, p. 168) remarks finally that the elongated and pointed posterior inner part of the tooth is remarkable, a similar shape not having been observed in any other anthropoid. Remane himself (p. 53, fig. 12) has remarked upon the extraordinary variation in the orang P_3 , and, as said above, the posterior inner angle of the crown is not as pointed as it has been drawn in Pilgrim's figure. This character also breaks down in the comparison with the long series of comparative material.

To follow further the history of the Haritalyangar tooth, Gregory and Hellman ('26), who reproduce Pilgrim's figures (fig. 10, 3) remark that it is much more advanced in structure than the P_3 in *Dryopithecus*, being less compressed and with the anterior part more expanded. Comparison with the specimens and casts in the American Museum of Natural History shows that this is undoubtedly true: in *Dryopithecus* the anterior and posterior protoconid ridges are much less obliquely set to the long axis of the crown, and the metaconid ridge is more antero-posterior (less transverse) in position. Consequently the anterior outer surface of the tooth is less wide than it is in the Haritalyangar tooth.¹ The anterior inferior extension of the buccal surface is less pronounced in *Dryopithecus* than it is in the orangutan (Gregory and Hellman, loc. cit., p. 43). This extension is called "moderate" both for *Dryopithecus* and *Sivapithecus*, as against "pronounced" in the orangutan (p. 85), but I can see no difference between the Haritalyangar P_3 and that of *Pongo pygmaeus*.

Pilgrim ('27) refers the Haritalyangar P_3 to *Sivapithecus himalayensis*, based on a left mandibular ramus with P_3 - M_2 from the same locality (Indian Museum, no. D.197). P_3 in this ramus, of which a cast is in the American Museum of Natural History too, is smaller than the specimen recorded in 1915 but stated not to differ from it essentially. This is a mistake; it does not agree well. The P_3 in the *Sivapithecus* ramus is, on the contrary, very much like the *Dryopithecus* front lower premolars. It is intermediate between *Dryopithecus* (*fontani*, *pilgrimi*, and *cautleyi*) on the one hand, and the Haritalyangar specimen and the orangutan on the other,

¹ Gregory and Hellman (p. 24) write that in *Dryopithecus pilgrimi* the P_3 is compressed, "not unlike that of a common macaque monkey." The resemblance is, however, not very close; the *Macaca* P_3 , especially in the male, is characteristic for its excessive downward protrusion of the enamel upon the antero-external surface, far more pronounced than it is in any anthropoid ape. The *Macaca* P_3 also is much more compressed laterally (anteroposterior diameter two to three times as long as the transverse diameter, as I measured these) and has a much higher talonid than the P_3 in *Dryopithecus* or *Sivapithecus*.

in the degree of the antero-inferior enamel extension on the outer surface, and in the angle between the protoconid ridges and the long axis of the crown. This is also evident from table 2, in which the antero-posterior diameter given is taken as well as possible parallel with the anterior and posterior protoconid ridges, and the transverse diameter was taken at right angles to the latter. The width-length index thus obtained is 100 for *Sivapithecus*, less for *Dryopithecus* and more for the Haritalyangar tooth.

The reference of the Haritalyangar P_3 to *Sivapithecus indicus* has not been questioned by Colbert ('35, p. 69), Lewis ('37, p. 144) and Wadia and Aiyengar ('38, p. 486).

Recently, Von Koenigswald ('50) has paid attention to this find again. He starts out with an isolated lower last molar from the Nagri formation near Alipur, in the eastern part of the Salt Range area, described by Pilgrim ('15, p. 27, pl. 2, fig. 8) as *Dryopithecus giganteus* (Indian Museum, no. D.175), remarkable for its size. The antero-posterior diameter is not less than 19.1 mm, the transverse diameter 15.3 mm, and the height 8.5 mm (Pilgrim's data, which agree completely with those taken from the cast in the American Museum of Natural History). Remane ('22, p. 165) states that this molar cannot be referred to *Dryopithecus*, but thinks it probable that it belongs to a separate genus which is closely related to *Pongo* (*Simia* auct.), perhaps even the very *Pongo*. Gregory and Hellman ('26, p. 74) have no objection to its reference to the genus *Dryopithecus*, however. Lewis ('37, p. 145) places the species in the genus *Sivapithecus*, and writes: "This species is one of the largest great apes recorded, surpassing the average and all but the largest gorillas in size, and being exceeded in this respect only by *Gigantopithecus*. With the exception of its giant size, the morphology differs from that of *Sivapithecus indicus* only in the minor detail of the lower molar crown's being slightly narrower."

In a collection of 446 specimens of subfossil M_2 and M_3 of the orangutan from Sumatra, only two exceed the Alipur M_3 in length (Hooijer, '48, M_2 no. 11 and M_3 no. 152: 20.1 mm

and 19.4 mm respectively). In the same collection, however, not less than 32 specimens exceed the Alipur molar in width. The height varies in 5 subfossil specimens from 7.0 to 10.9 mm, and in 7 recent from 6.4 to 10.4 mm (Hooijer, loc. cit.).

Von Koenigswald ('50, p. 515) writes that some fossil orang molars from the Pleistocene of China also exceed the Alipur molar in size, but that the latter cannot belong to the orangutan because of its coarser enamel wrinkles and higher crown. According to Von Koenigswald (p. 517) the Alipur molar belongs neither to *Dryopithecus* nor to *Sivapithecus*, and he refers this tooth to a new genus: *Indopithecus*, with the generic type *Dryopithecus giganteus* Pilgrim. No definition of the genus is given except for the differences from the orangutan just mentioned. There can be no doubt, it is true, that the Alipur molar does not belong to *Pongo pygmaeus*, for it has much more distinct and less marginally placed cusps, nothing in comparison with the system of fine enamel wrinkles that covers the orangutan molars, and the marginal ridges are less well developed though the tooth has a distinct "tuberculum 6" (not well shown in Pilgrim's figure, pl. 2, fig. 8). On the other hand, I cannot perceive tangible differences between the Alipur M_3 and those of *Sivapithecus*.

The P_3 from Haritalyangar dealt with in the foregoing pages of this paper is considered by Von Koenigswald to be the only find that might belong to the species *Indopithecus giganteus* (Pilgrim) other than the type specimen. He finds in the literature that in recent anthropoids M_3 is 1.0 to 3.2 mm wider than P_3 , and that the Haritalyangar P_3 is 1.2 mm less in its transverse diameter than the type M_3 of *Sivapithecus giganteus*. Thus these two isolated teeth might very well belong together, Von Koenigswald holds; in *Dryopithecus cauleyi* with a width-difference between P_3 and M_3 of 4.8 mm (Gregory and Hellman's measurements) P_3 would be relatively too small. Considering further that the anterior portion of the Haritalyangar P_3 shows a few coarse enamel wrinkles (trigonid fossa?) there can be no doubt that this premolar belongs to the same species as the molar described by

Pilgrim as *Dryopithecus giganteus* (Von Koenigswald, '50, p. 516).

The comparison of the two isolated teeth with their homologues in the type mandibular ramus of *Dryopithecus cautleyi*, using my own measurements throughout, shows (table 3) that the same ratio between the robustnesses of P_3 and M_3 exists

TABLE 3

Measurements (mm) of P_3 and M_3 of *Dryopithecus cautleyi*, and of the *Haritalyangar* and *Alipur* teeth

	DRYOPITHECUS CAUTLEYI		HARI- TALYANGAR P_3	ALIPUR M_3
	P_3	M_3		
Antero-posterior	12.0	13.7	16.4	19.1
Transverse	7.5	12.3	10.3	15.3
Robustness	90.0	168.5	168.9	292.2
Ratio $\frac{\text{robustness } P_3}{\text{robustness } M_3}$	0.53		0.57	

TABLE 4

Measurements (mm) of P_3 and M_3 of recent and subfossil orang-utan

	<i>Pongo pygmaeus</i> (Hoppius)			
	recent		subfossil	
	P_3	M_3	P_3	M_3
Antero-posterior	15.0	13.6	15.9	14.5
Transverse	9.8	12.3	10.6	12.9
Robustness	147.0	167.3	168.5	187.0
Ratio $\frac{\text{robustness } P_3}{\text{robustness } M_3}$	0.88		0.90	

in *Dryopithecus*. In other words, by *Dryopithecus* standards the two finds might belong together. Not, however, by orangutan standards. The mean values for the dimensions of P_3 and M_3 in long series of recent and subfossil orangutan (after Hooijer, '48, pp. 224 and 264) show (table 4) that in this anthropoid, in the average, P_3 is much more robust relative to M_3 than it is in the one jaw of *Dryopithecus*.

In *Sinanthropus* (Weidenreich, '37), the modern White (Black, '02), the Australian (Campbell, '25) and the Bantu (Middleton Shaw, '31), all average figures, P_3 appears to be of about the same size relative to M_3 as it is in *Dryopithecus* (table 5).

Von Koenigswald further remarks that the Haritalyangar P_3 is very short, and agrees in its index with *Sinanthropus* and recent man rather than with the anthropoids, thereby relying on the indices given by different authors. It has already been shown above that this is a very unreliable method of comparing specimens and apt to lead to wrong conclusions, especially in the present case.

TABLE 5

Measurements (mm) of P_3 and M_3 of *Sinanthropus*, the Modern White, the Australian and the Bantu

	SINANTHROPUS		MODERN WHITE		AUSTRALIAN		BANTU	
	P_3	M_3	P_3	M_3	P_3	M_3	P_3	M_3
Antero-posterior	8.6	11.7	6.9	10.7	7.6	11.9	7.1	11.1
Transverse	9.9	11.2	7.9	9.8	8.8	11.1	8.2	10.4
Robustness	85.1	131.0	54.5	104.9	66.9	132.1	58.2	115.4
Ratio $\frac{\text{robustness } P_3}{\text{robustness } M_3}$	0.65		0.52		0.51		0.50	

In his discussion of the morphology of the Haritalyangar P_3 Von Koenigswald bases himself on Pilgrim's figures, and writes that the inner cusp is distinct (Pilgrim had written: "a faint secondary cusp"), by which the tooth becomes "praktisch bicuspid" (Von Koenigswald, '50, p. 518), as is the hominid P_3 . The tooth is furthermore stated to present a right angle at the posterior outer corner ("einem rechten Winkel an der hinteren Aussenecke") while in reality it is the anterior angle of the crown that is a right angle. Von Koenigswald feels that in the shortening of the anterior portion of the crown, in the anterior enamel border not extending downward, and in the position of the greatest width being

beside and not in advance of the main cusp the tooth deviates from the sectorial-typed anthropoid P_3 and approaches the conditions ("den Verhältnissen") shown in the hominids (loc. cit.). A few lines further down it is the "non-sectorialen," and then again the "vermenschlichte" (humanized) type of P_3 that makes *Indopithecus* so peculiar.

As Pilgrim's figures convincingly show, the Haritalyangar P_3 differs from the hominid P_3 in the same points as does the orangutan P_3 . The lingual surface is flattened instead of being strongly convex from side to side as it is in *Homo* (and even *Sinanthropus*; Weidenreich, '37 [atlas] figs. 79, 80, etc.). No hominid P_3 , when seen in crown view, has the antero-buccal and postero-lingual projections as shown in the Haritalyangar specimen, making the long axis so oblique in its course. The protoconid is central in position instead of being displaced toward the buccal side. In fact the chimpanzee P_3 figured by Weidenreich (fig. 81) is much more nearly human than is the Haritalyangar tooth.

There is, I think, not the slightest justification for the view that the Haritalyangar premolar is non-sectorial and humanized; its anthropoid characters are as pronounced as they are in the orangutan.

With this I do not mean to say that the present specimen indicates the presence of the orangutan in the Mio-Pliocene Nagri formation of the Siwaliks. The subfossil orangutan from Sumatra has a P_3 with the tendency to be larger and lower-crowned than its recent homologue (Hooijer, '48, p. 224), and a fossil P_3 of the orangutan from the Pleistocene of China (Weidenreich, '37, p. 74 [atlas], fig. 88) is again larger. We do not know much as yet about the evolution of the orang dentition in the Pleistocene, but the study of the prehistoric and Pleistocene canines indicates that the C of the orangutan has become smaller and more hypsodont in the course of time (Hooijer, '48, p. 289). Thus it would seem very probable that the P_3 has undergone significant changes during the Quaternary too. Hence it is extremely improbable that this Mio-Pliocene tooth, which has the same size and

structural characters as the recent P_3 of the orangutan, belonged to *Pongo pygmaeus*.

The Haritalyangar premolar shows us only that, besides *Dryopithecus* and *Sivapithecus*, there was an ape in the Nagri formation of the Siwaliks which in its P_3 had already acquired the specializations typical of the orangutan of today.

Whether or not the Alipur M_3 belonged to the same form is, of course, impossible to settle definitely. We have seen above that this molar is too large to have belonged to the Haritalyangar P_3 by orang standards. On the other hand it cannot, in my opinion, be proven that it does not belong to the genus *Sivapithecus*. Its trivial name *giganteus* is well chosen, but this molar has no other claim to any close relationship with *Gigantopithecus*. The reference of this molar to a new genus by Von Koenigswald is based not so much on the characters of the molar itself as on the supposition that it is conspecific with the Haritalyangar P_3 . The generic type of *Indopithecus* Von Koenigswald is *Dryopithecus giganteus* Pilgrim, and the type specimen of *Indopithecus giganteus* (Pilgrim) is the Alipur M_3 . The Haritalyangar P_3 is only a referred specimen.

As to the generic and specific determination of the Haritalyangar P_3 I would suggest cf. *Pongo pygmaeus* (Hoppius) subsp., because there are no morphological differences to be found. The geological evidence, however, is against this procedure, and I feel quite certain that upon the discovery of more complete specimens morphological differences will appear which will make it possible to describe and determine the status of a new fossil anthropoid ape in the Mio-Pliocene of the Siwaliks about which we now only know that it is indistinguishable in its P_3 from the common orangutan.

SUMMARY

An isolated right P_3 identified by Pilgrim ('15) as *Sivapithecus* cf. *indicus*, and originating from the Nagri zone of the Siwaliks, is redescribed and found to be identical in all characters with the P_3 of *Pongo pygmaeus* (Hoppius). A sim-

ilarly isolated right M_3 from the same zone, originally identified by Pilgrim ('15) as *Dryopithecus giganteus*, apparently represents a large *Sivapithecus* species. Upon the rather doubtful association of these two specimens Von Koenigswald ('50) recently based the new genus *Indopithecus*, remarkable for its giant size and humanized non-sectorial P_3 . The critical tooth, however, belongs to a large anthropoid, and its morphology suggests *Pongo pygmaeus* (Hoppius) while on the other hand the identification with this species is rendered very improbable on the basis of what we know about the evolution of the dentition of the orangutan in connection with the geological age of the specimen. There is not the slightest reason to consider this tooth to have a bearing on the problem of the evolution of giant hominids.

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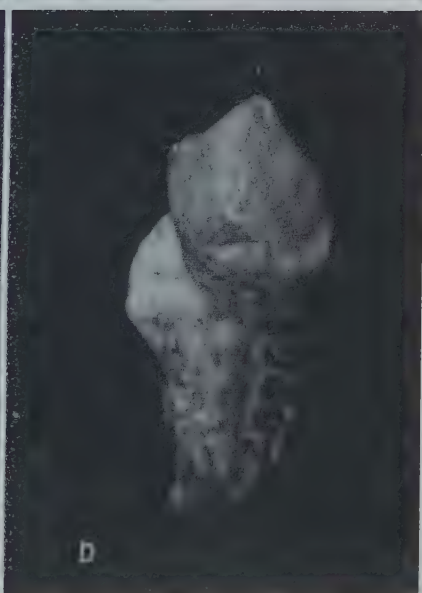
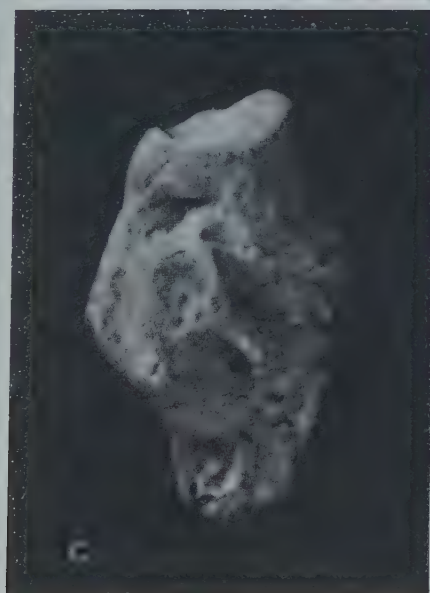
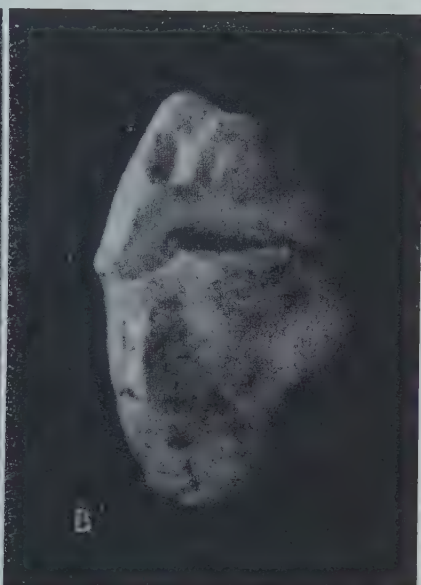
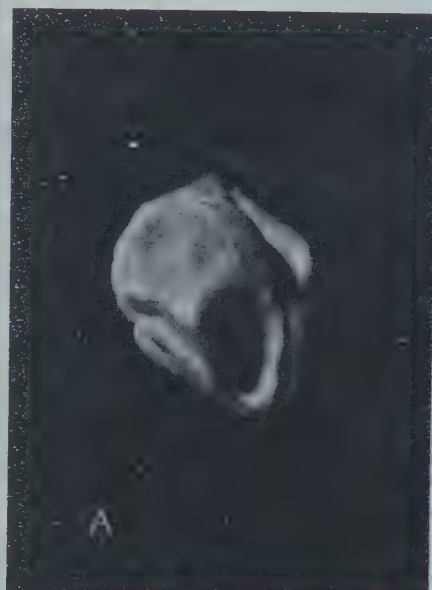
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EXPLANATION OF THE PLATE

PLATE 1

Cf. *Pongo pygmaeus* (Hoppius) subsp., right P₃ originating from Haritalyangar, Simla Hills, Bilaspur State, Punjab (Nagri zone of the Siwaliks): A, crown view; B, lingual view; C, buccal view; D, antero-external view. All figures 2 × natural size.





NORMAL BLOOD PRESSURE.—Establishment of industrial medical services on a large scale during the war afforded an opportunity to obtain blood pressure readings for large numbers of persons who were in average good health and able to work. . . .

The majority of persons included were at work, but the study also included those applying for employment, whether or not they were rejected. The study covered executive, clerical and manual workers, both skilled and unskilled, although attempt was made to identify specific occupations. Likewise, records did not show whether the individuals were White or Negro, but the great majority were of the White race. Altogether, unselected records of about 74,000 persons in 16 industrial plants and army airfields (civilian personnel only) were collected. Because of the large volume of material, random samples were taken in order that there should be at least 400 observations for men and for women in each age group. In a few instances, however, when the number available was less than 500, all the cases were used. The data tabulated cover 15,706 persons (7,722 men and 7,984 women) in 11 of the installations. The age range was 16 to 65 years. The volume of the data for ages over 65 years was so small that this part of the material was omitted. Samples were taken at the ages of 16, 17, 18 and 19, in order to determine, particularly in males, the variation at individual ages during the period before full growth has been attained.

In order to clarify . . . the influence of body build on blood pressure, the material was analyzed according to the 4 weight classes separately for short, medium and tall men. It was evident from this detailed analysis that weight showed a consistent influence on the level of the blood pressure. The averages for both systolic and diastolic values tended to rise with increase in weight in every height class. However, the effect of height on blood pressure seemed to be negligible, because no systematic trend in the averages was noted with respect to height in the several weight groups.—Arthur M. Master, Louis I. Dublin and Herbert H. Marks. The normal blood pressure range and its clinical implications. *J. Am. Med. Assn.*, vol. 143, no. 17, August 26, 1950, pp. 1464–1470.

MORRIS STEGGERDA

1900-1950

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MORRIS STEGGERDA

With the passing of Morris Steggerda, physical anthropology lost its noblest living humanitarian.

The annals of his life are quite simple. In 1847, a colony of Dutch settled Central Michigan; one of the towns they

founded is called Holland. Here and of these people Morris Steggerda was born September 1, 1900; his parents being John and Sena (Ter Vree) Steggerda. He obtained his A.B. at Hope College, in his native town (1922); his A.M. and Ph.D. (1923, 1928) from the University of Illinois, in the Department of Zoology. From 1928 to 1930 he was an Assistant Professor of Zoology at Smith College (Northampton, Mass.); from 1930 to 1944, he was an Investigator with the Carnegie Institution of Washington at Cold Spring Harbor (Long Island); thereafter, until his death, Professor of Anthropology at Hartford Seminary Foundation (Connecticut). He was a member of Sigma Xi; Gamma Alpha; the American Zoological Society; American Association for the Advancement of Science; American Society of Naturalists; Eugenics Research Association; the Eugenics Society (hon. Mem.); the American Anthropological Association (Council). He was elected a member of the American Association of Physical Anthropologists at the time of its organization (1930); from 1943 to 1946 he served on its Executive Committee; from 1946 to 1948, he was its Vice President.

The men and women who came from the Netherlands to Central Michigan had hands that drew from the earth its abundant goodness. They were staunch and simple Protestants. They made Morris Steggerda. This forthrightly accounts for his early and intimate interest in birth, growth, and the intermingling of biological strains—the procession of generations in plant, fowl, mammal, and man. He not only watched but he caused things to grow; and he took unflagging delight in measuring and recording their movement in time.

By 1926, young Steggerda, with his training in genetics and psychology, had attracted the attention of Charles Davenport. Under the auspices of the Department of Genetics, Carnegie Institution, together they explored the natives of the British West Indies (1926–1928); out of this there issued not only Steggerda's doctoral dissertation (on the Negro-White hybridizations) but a series of publications, most no-

tably the *Race-Crossing in Jamaica*, under joint authorship of the two collaborators (1929).

In those days, the American Journal of Physical Anthropology already had a number of years behind it; but physical anthropology was scattered very thinly indeed over the American academic landscape. In 1930, our Association was founded, and Dr. Steggerda became a member. Meanwhile, in 1928, he had married Inez Dunkelberger, an instructor under Professor Wilder at Smith College. In 1932, Charles Steggerda was born. The fourteen years, from 1930 to 1944, were rich and full. There were two trips to Europe and ten to Yucatan; numerous visits to Tuskegee Institute, to the Navajo Reservation; and back to Holland, Michigan, where Steggerda's own ethnic kin entered into those voluminous archives of anthropology which are a large part of his scientific legacy.

He could not have known that his delight in the growth of a living thing was his poetry. He loved the clod of soil — "the Good Earth" — held in the hand; it was all of a piece with the fact that he measured the living bodies of men, women, children, babies — but dead bones almost never. People were his fellow-humans: Maya, Navajo, Chinese, American Negro knew him in that way. It explains how he managed to get a Maya Indian to write a diary and put it into his hands; it also explains a simple experiment that seems tinged with a touch of genius. In Yucatan, he planted and grew maize on a plot of ground, along with his Maya friends, and in their way; but under careful scrutiny and recordings. He learned thus how rapidly their soil could be depleted; it has been said that this one thing has done more to clear up the mystery of the passing of early Mayan economy than many speculations about it.

His last six years brought a new and intense career — a new way to make things grow that came as a culmination: to him it seemed that "last of life for which the first was made." Morris Steggerda, Dutch-American Protestant, geneticist, measurer of man, lover of Mayas, Navajos, Ne-

groes, Whites, was happiest while training missionaries and missionary candidates in anthropology. He was convinced that Christianity has something to offer to Most of the World; but that the offering must be intelligent and discriminating. It was characteristic of him to think that others could do a better job of it than he could; he undertook the task because no other would. His heart, however, had already given him one grim warning; he went to the task none the less.

Those of us who walked with Morris Steggerda on his last, short journey beheld a wonderous thing. People from far and near came to walk with him; others sent messages. Letters poured in from the other side of the world. Some of these people were men who shared with him the intellectual climate of science; some were ministers; many were simply those whose only contacts with him could be the facets of a common humanness. For Morris Steggerda knew how to draw forth growth not only from the good earth but also from the people who tread it.

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NOTE

WILTON MARION KROGMAN

FIFTH RECIPIENT OF THE VIKING FUND MEDAL
AND PRIZE IN PHYSICAL ANTHROPOLOGY



WILTON MARION KROGMAN

The annual Viking Fund Awards were made on February 9, 1951, at a dinner held at the Waldorf Astoria in New York and presided over by Mr. Wenner-Gren. Dr. T. D. Stewart, as President of the American Association of Physical Anthropologists, made the following speech of presentation to Dr. Krogman:

The American Association of Physical Anthropologists unanimously selected Dr. Wilton Marion Krogman for the Viking Prize and Award in physical anthropology for 1950. On the last occasion, this honor was bestowed upon Dr. Gregory for his phylogenetic studies bearing on the infancy of mankind. This time, in keeping with the tremendous scope of the field of physical anthropology, our Association is paying tribute to Dr. Krogman largely for his ontogenetic studies on today's human infants. This range of interest, which encompasses the whole of man's evolutionary history, points up the statements I made last year, namely, that "a physical anthropologist is identified by his point of view regarding man rather than by his attachment to a particular branch of science," and "physical anthropology draws together from all sciences those who seek a broader biological perspective on mankind."

Dr. Krogman is a product of the Middle West. He was born, raised and educated in Illinois. He has spent most of the 20-odd years since receiving the Ph.D. degree at the University of Chicago in that occupational zone where physical anthropology and medicine overlap, especially in anatomy and child growth. He has been Associate Professor of Anatomy and Physical Anthropology, successively, at Western Reserve University and the University of Chicago. It was at Western Reserve and under the influence of the late T. Wingate Todd that he shaped his future course. At present he is Professor of Physical Anthropology at the Graduate School of Medicine in the University of Pennsylvania and Director of the Philadelphia Center for Research in Child Growth.

Dr. Krogman has long been interested in the growth of the child. To provide a broad basis for future study, he began 20 years ago to investigate age changes in anthropoids. Writing in the *Zeitschrift für Rassenkunde* in 1938, he said: "... the problem of human growth—originally tackled by the anthropometric yardsticks of height, weight, and their correlated phenomena—has now ramified into the broadest fields of human biology; medicine, chemistry, genetics, physiological psychology. The child is the sum total of an

environment beginning in his family line and extending through every physical, psychological or cultural vicissitude; his "type," though set in a certain pattern, is modifiable at every stage of development. We are seeking to learn of the modifying factors; we are trying to interpret possible effects and assess their ultimate outcome."

He went on to say that "a study of this nature has the most vital relationship to anthropology in that the more we learn of the individual growth process and its stability or modifiability the more we may be able to lay down certain principles of evolutionary progress. It is important to know whether a form of trait is plastic or set; from the one we may expect new forms, from the other extinction or mere succession. The emergence of racial types," he concluded, "may reside in the stabilization of certain growth patterns."

With this sort of study in mind, Dr. Krogman has been able since 1947 to plan his own program in Philadelphia. There he now examines annually 600 children between the ages of 7 and 13 years. And in addition he is following semi-annually 200 orthodontic and 100 cleft-palate cases. From all this material the results are beginning to flow, as the titles of the following recent articles indicate: "The assessment of degree of deviation from the normal in face and teeth"; "The concept of maturity from a morphological viewpoint" and "A handbook of the measurement and interpretation of height and weight in the growing child."

I call your attention to the emphasis here on the face. Besides general growth, Dr. Krogman is interested in the detailed growth of the facial parts as affected by the eruption of the teeth. Modern man is prone to have malposed teeth and associated facial distortion. Mechanical and surgical interference in the mouth during the growth period requires careful consideration in terms of continuing growth and the natural potential for readjustment. To these very practical matters Dr. Krogman brings a rich experience and a faculty for promoting an easy interdisciplinary working relationship.

The liaison between physical anthropology and the field of medicine extends naturally from the morphological aspects of growth to medico-legal problems. Traditionally the skeletal remains encountered in the course of archaeological excavations have been the subject of study by physical anthropologists. It is an easy step from this to the identification of suspected skeletal remains for law enforcement agencies. But Dr. Krogman is not satisfied with a routine job; he brought to this work new ideas developed in Todd's anatomical laboratory where carefully identified skeletons had been assembled.

His success as a "bone detective" led him to publish his methods for the use of all. In Dr. Krogman's hands the skeleton talks.

In one medico-legal case, involving a half-breed Indian, the skeleton talked so well that Dr. Krogman got the idea of studying race mixture in the Seminole Indians of Florida and Oklahoma. The main resulting publication, which appeared in Rome in 1935, is one of the best contributions to the physical anthropology of the American Indians in their present mixed state.

Curiously, Dr. Krogman has not extended his work on living Indians to their skeletal remains. There are rumors that he was scared out of American archaeology at the Seip mound in Ohio while still a graduate student. The fact is, however, that he has avoided American Indian skeletons and turned instead to those from the Near East, and especially those in the Oriental Institute from Alishar Hüyük. An NRC fellowship enabled him to go to England in 1930-31 where he was able to work up his observations of the Alishar specimens with the assistance of Sir Arthur Keith and others. There also he had an opportunity to study a skull that Bertram Thomas had brought back from Arabia. Since then he has described early material from other parts of the Near East. He is thus one of the few authorities in this specialized field.

No one can investigate the remains of the peoples who lived at that ancient cross-roads of mankind which is the Near East without being conscious of morphological race differences. From this experience, and from his experience in American dissecting rooms, as well as from that of studying the Seminoles, Dr. Krogman has derived a real appreciation of the biological concept of race. Although he has followed carefully the recent developments in genetics, he has not been swept off his feet by the vogue for an impractical genotypic classification of race as applied to man. Nor is he sympathetic toward the efforts of some to combat racism by enclosing the word race with quotes, "as if by so doing they can, in effect, recognize [the] existence [of race] while denying its implications." In short, he has clarified rather than confused the issue between race and racism.

I have said enough, I believe, to show that Dr. Krogman's contributions in the field of physical anthropology have been in several directions and meritorious. I would be remiss if I did not say something also about his general services to his science. He is an outstanding bibliographer. His *Bibliography of Human Morphology* is an indispensable guide to this segment of the literature for the years 1914 to 1939. He contributes also a monthly installment to the section of Biological Abstracts dealing with human biology. On the promotional side, Dr. Krogman has served a double term as

president of the American Association of Physical Anthropologists, an honor shared only with the Association's founder. Currently he is promoting the interests of his science through the chairmanship of its special committee in the NRC.

The approved citation with which I shall close these brief remarks will serve as a summary. I am happy, therefore, Mr. Wenner-Gren, on behalf of the American Association of Physical Anthropologists, to present Dr. Wilton Marion Krogman for the Viking Prize and Award for 1950 "in recognition of (1) his outstanding work in the field of child growth and orthodontics; (2) his skilful liaison work between the fields of medicine and physical anthropology, with particular reference to the science of legal medicine; and (3) his valuable contributions on the racial prehistory of the Near East, and for his sane and objective publications upon race problems generally."



LATE PHASES OF HUMAN EVOLUTION.—The accumulation of evidence regarding pre-Mousterian Man—in particular that provided by the fossil remains found at Swanscombe and Fontéchevade—makes it reasonably certain that the extreme Neanderthal type of Man in Europe was a collateral line of evolution having no direct reference to the origin of *Homo sapiens*. Further, it appears probable on chronological grounds that extinct types of Man with neanderthaloid characters in other parts of the world (such as *Homo soloensis* and *Homo rhodesiensis*) were also aberrant types. Lastly, the recent demonstration by Dr. Oakley (1950), on the basis of the fluorine test, that the cranial fragments and the mandible found at Piltdown are, after all, of the same geological age, and that they are referable to the later rather than the early Pleistocene, provides evidence of still another collateral line in the evolutionary radiations of the Hominidae. For these most important observations appear to weight the circumstantial evidence overwhelmingly in favour of those who had claimed that the remains belong to one individual, and at the same time make it difficult to avoid the conclusion that "Piltdown Man" was a somewhat specialized type that persisted until relatively late times.—W. E. LeGros Clark. New palaeontological evidence bearing on the evolution of the Hominoidea. Quart. J. Geol. Soc. London, vol. 105, pt. 2, no. 418, 1950, pp. 225–264.

THE PARA-SAGITTAL GROOVE.—The applications of genetical concepts in racial analysis need not necessarily be limited even at this time to the serological genes. As an example, let us consider that trait of the extinct Tasmanians which has been considered by so many authorities to represent an exclusive trademark, the para-sagittal groove. Many Tasmanian crania characteristically show on either side of the sagittal keel and medial to the parietal bosses a a trough-like or grooved configuration. There has been a marked tendency in the literature to accept this trait as being uniquely Tasmanian and to make no further inquiry as to its possible origin or the frequency of its distribution in other groups. Admittedly it has been noticed as an infrequent occurrence among the Murrayian crania of southern Australia. The author suggests that this trait, the para-sagittal groove, is a genetic consequence of the hybridization of markedly differing cranial types. It is hypothesized that the trait results when one parental type is characterized by a strongly marked sagittal keel and the other parental type shows a high frequency and marked development of the parietal bosses. If this assumption be true, then such mixtures may be presumed to have occurred in other regions of the world than Tasmania. Even in my limited personal experience this condition is fulfilled. For example, not only is the para-sagittal grooving present among Baining crania from New Britain, but a cursory examination of the rest of Melanesia shows that this condition is in fact a common one. It may be further recorded as occurring with high frequency among the inhabitants of the channel islands of southern California, specifically Santa Catalina and Santa Cruz. While the occurrence of the trait in Melanesia might be interpreted by some anthropologists as indicating the presence of a Tasmanian race in these regions, this belief can hardly be maintained for the Monogoloid peoples in southern California. There is, however, evidence for the belief that in all of the groups mentioned above there has occurred in fact hybridization between a long-headed, strongly keeled cranial type and a shorter-headed cranial type characterized by a rather flat vault but marked parietal bosses. It may confidently be expected that when the mode of inheritance of sagittal keeling and parietal bosses has been thoroughly analyzed, it will be found that the trait called para-sagittal grooving will be identified as a genetic consequence of the hybridization of parental groups characterized by the former traits. The para-sagittal grooves can hardly be considered longer as a unique morphological development, limited to the Tasmanians.—Joseph B. Birdsell. The racial origin of the extinct Tasmanians. *Rec. Queen Victoria Mus., Launceston*, vol. 2, no. 3, August, 1949, pp. 105–122.

REVIEW

THE ANATOMY OF THE GORILLA. (The Henry Cushier Raven Memorial Volume.) The Studies of Henry Cushier Raven and Contributions by William B. Atkinson, Herbert Elftman, John Eric Hill, Adolph H. Schultz, William L. Straus, Jr., S. L. Washburn. Arranged and edited by William King Gregory. Columbia University Press, New York, viii + 259 pp., 41 figures, 116 plates. 1950. \$15.00.

If one's friends are his fortune Henry Cushier Raven was indeed a wealthy man. Guided by William King Gregory they have brought forth a superb volume which includes not only Raven's notes and drawings but also contributions from their own studies.

Perhaps 1929 may be taken as the official beginning of this work but the concept must have been in Raven's mind many years before that. In that year an expedition sponsored by Columbia University and The American Museum of Natural History went to Africa to obtain material. The project was interrupted in 1944 by the death of Raven and again in 1947 by the death of Hill.

Part One is a short biographical sketch by Dr. Gregory. It is an amazing dramatic story of a man who traveled North America, the East Indies, Africa, Australia, Greenland and Africa again, always with a purpose. It is absorbing reading and it is to be hoped that in the near future it will be expanded into a long saga for the general reader.

Part Two covers nearly 200 pages of text and illustrations. This for the most part represents Raven's own work, his notes and drawings. The notes on the muscles and the peripheral nerves are the most complete but there are good though rather brief descriptions of the other systems. The illustrations which are almost entirely line drawings are more comprehensive. These are arranged as 41 text figures and 96 plates. Four plates are life size. Two, each 100 cm long, are of the muscles of the superior extremity. Of the other two, which are naturally slightly shorter, one is of the muscles of the inferior extremity, the other of the vessels and nerves.

The text and illustrations are completely descriptive macroscopic anatomy. Both are characterized by clarity, simplicity and conciseness.

Perhaps the devotion of Raven's friends to their task is best seen in the story of the mounted skeleton. Finding no suitable articulated skeleton John Eric Hill and Brenda Putnam collaborated in preparing one. First photographs of gorillas were obtained, living animals were studied, dissections were used for reference, sketches were made and finally a large gorilla was modeled to scale by Brenda Putnam. This thoroughness is characteristic of the entire volume.

Parts Three, Four and Five are adequate and desirable contributions by colleagues to round out the work. S. L. Washburn describes the thoracic viscera; H. Elftman and W. B. Atkinson, the abdominal viscera and female reproductive system; W. L. Straus, the microscopic anatomy of the skin. The concluding section, Part Five, is Morphological Observations on Gorillas by A. H. Schultz. In it are discussed age changes in size and proportions, palatine ridges, dentition and the skull. In his summary he calls attention to the "enormous variability of gorillas."

As one reads the work he is impressed by two things, first, the wealth of information it contains; second, the enormous amount of work yet to be done.

There is over the years a wealth of material in this country. A reasonable hope would be that this major contribution may stimulate some group, perhaps the physical anthropologists, to utilize this material to build on this cornerstone so well laid.

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ON THE INCIDENCE OF SOME OF THE NEW BLOOD AGGLUTINOGENS IN CHINESE AND NEGROES

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During the last 5 years a number of previously undescribed natural and immune agglutinins for human blood have been discovered. With the aid of such agglutinins the incidence and genetic transmission of the corresponding agglutinogens have been determined. In the recent past only 4 well established blood group systems were known. These were the A-B-O, M-N, P, and Rh-Hr systems. The newer agglutinins have either defined new systems or have increased the number of allelomorphs within previously known systems. Additional blood group systems have been disclosed with the aid of anti-Kell (K), anti-Cellano (k), anti-Lutheran (Lu^a), anti-Le^a, anti-Le^b, and anti-Duffy (Fy^a). The Kell and Cellano antisera react with antigens that are genetic allelomorphs (Sanger, Bertinshaw, Lawler, and Race, '49; Levine, Wigod, Backer, and Ponder, '49). A similar situation exists for the Le^a and Le^b antisera (Mourant, '46; Andresen, '48), although here the relationship is more complicated. Antithetical sera for the Lutheran (Callender, Race, and Paykoc, '45) and Duffy (Cutbush, Mollison, and Parkin, '50) blood group systems have thus far not been found. Other recently discovered antisera for human red cells are rh^w (Callender, Race, and Paykoc, '45), hr^{''} (Mourant, '45), and S (Walsh, and Montgomery, '47). The first two have made possible the recognition of additional allelomorphs within the Rh-Hr system. The S antibody divides the M-N types either by

increasing the number of alleomorphs in this system or by defining a gene closely linked to the MN locus. At the present time we are able to study the blood group factors of 8 probably independent systems.

Previous studies with the newer agglutinins have been more or less limited to the Caucasian group and have been summarized by Race and Sanger in *Blood Groups in Man* ('50). Because it is known that the frequency distribution of formerly studied blood factors differs in many of the various racial groups, it was believed that it would be of interest to determine the incidence of some of these newly discovered agglutinogens in other racial groups, namely, the Chinese and Negroes. Unfortunately, anti-Lu^a, anti-rh^w, and anti-hr^{''} sera were not available to us in sufficient quantity for this study.

MATERIALS AND METHODS

The bloods tested were venous samples obtained from 103 Chinese and 200 Negroes, all residents of New York City. Although it was not possible to obtain complete information as to the origin of the Chinese subjects it was our impression that they were full-blooded and predominantly Cantonese. The degree of racial admixture for the Negroes was not determined. However, dark skinned subjects were selected. The tests were usually performed within a day or two after the blood specimens were obtained.

The anti-A, absorbed B, anti-B, anti-P, anti-Le^a, and anti-Le^b sera contained naturally occurring antibodies from human blood donors. The anti-S (cf. Race and Sanger, '50, p. 59) and anti-Fy^a (Rosenfeld, Vogel, and Race, '50) agglutinins were from male donors whose sera contained these antibodies prior to any known blood transfusions. However, the sera used in this study were obtained after increases in the potency of the agglutinins were evident following injections of stimulating doses of blood of the appropriate types. M and N antisera were from immunized rabbits. Several examples of each type were used. In addition, many bloods

were tested with two examples of naturally occurring anti-M obtained from human donors. The anti-Rh₀, anti-rh', and anti-rh'' sera were obtained from a commercial source and retested for potency and specificity prior to their use. The anti-hr' serum was derived from a mother who delivered an erythroblastotic infant. The serum was free of anti-rh'', having failed to agglutinate a few bloods known to be Rh₀Rh₁. The anti-Kell (K) and anti-Cellano (k) sera were kindly supplied by Dr. P. Levine.

The group agglutinins of the various sera were usually removed by absorption with blood of the appropriate types. In the cases of the anti-S and human anti-M sera the group agglutinins were neutralized with concentrated group specific substances (Sharpe and Dohme).

The test tube technique was used throughout this study. One drop of a 4% saline suspension of red cells was added to two drops of the antisera and the mixtures allowed to stand for 60 to 90 minutes. Tests with the grouping, absorbed B, M, N, and Le^a antisera were carried out at room temperature. The Rh-Hr, K-k, S, and Fy^a tests were performed in the water bath at 37°C. Tests with the anti-P serum were performed at 4°C. The tests with the anti-Le^b serum were carried out at 14-16°C.

All the antibodies except for K and Fy^a were of the complete variety. The latter were incomplete agglutinins so that following incubation of the red cell suspensions with these sera, sensitization was determined with the indirect anti-globulin test (Coombs, Mourant, and Race, '45). In addition, all bloods reacting negatively to the complete variety of anti-Rh₀ serum were incubated with two examples of incomplete anti-Rh₀ sera and then tested for sensitization with the indirect anti-globulin test.

RESULTS

The results obtained from the testing of the bloods of Chinese and Negro subjects with the various antisera used

in this study are presented in the following tables and paragraphs. The frequency distributions of the various blood factors in these two racial groups are compared with their incidence in Caucasians as observed by others.

Blood groups and subgroups. The incidence of the B factor in Chinese and Negroes is about twice that occurring in Caucasians. An even more striking difference is found in the subgroups of A. The A_2 factor is either absent or very rare in the Chinese (Wiener, Sonn, and Yi, '44). This has also been found to be true in other Asiatic ethnic groups. On the other hand the ratio of A_2 to A_1 in Negroes is higher than in Caucasians (Wiener, Belkin, and Sonn, '44).

M-N-S System. In the present study it can be seen (table 1) that the distribution of the three M-N types in the three racial groups concerned is similar. However, slight differences are present in that the Chinese had more M and the Negroes less M than the Caucasians. This finding for the Chinese is probably not due to chance as Alley and Boyd ('43) in a study of the M-N types in Chinese from Canton obtained almost identical data. In Caucasians, about three-fourths of type M bloods and about one-third of type N bloods are S positive, with an overall frequency of S positives being approximately 55%. In the Chinese and Negroes the incidence of S positives is 10.7 and 29.5% respectively. The absolute number of S positives in the Chinese series is too small to reveal whether this factor is more closely associated with the M factor than the N factor as in Caucasians. In the Negroes the S factor appears more frequently in type M bloods than in type N bloods. However, the highest incidence of S positives is in MN bloods. This finding seemed unlikely since the incidence of S in the latter should lie somewhere between its incidence in M and N bloods. In order to further investigate this unexpected result it became necessary to further verify the specificity of the M, N, and S testing sera. Two hundred bloods from Caucasian donors were tested and the

TABLE 1

Comparative incidence of the blood factors of various racial groups

SYSTEM	TYPES	CAUCASIANS	CHINESE (Present study)	NEGROES
O-A ₁ -A ₂ -B	O	43.8 ¹	45.6	50.0
	A ₁	30.4	27.2	15.0
	A ₂	8.6	0.0	7.0
	B	12.6	22.3	23.5
	A ₁ B	3.4	4.9	2.5
	A ₂ B	1.2	0.0	2.0
M-N-S	M.S	20.8 ²	3.9	6.9 ³
	M.s	7.5	35.0	17.2
	MN.S	26.7	5.8	16.6
	MN.s	22.7	37.9	33.1
	N.S	7.2	1.0	26.0
	N.s	15.1	16.5	20.2
P	P +	77.0 ⁴	27.2	95.0
	P —	23.0	72.8	5.0
Rh-Hr	rh	14.4 ⁵	1.0	5.5
	Rh ₁ Rh ₁	19.5	53.4	2.0
	Rh ₁ rh	31.5	11.7	24.5
	Rh ₂	16.3	8.7	16.0
	Rh ₁ Rh ₂	14.4	24.2	5.0
	Rh ₀	2.5	1.0	46.5
	rh'	1.0	0.0	0.5
	rh''	0.4	0.0	0.0
Kell-Cellano (K-k)	K	0.3 ^{6,7}	0.0	} 3.5
	Kk	9.9	0.0	
	k	89.8	100.0	
Duffy (Fy ^a)	Fy ^a +	66.0 ⁸	99.0	26.0
	Fy ^a —	34.0	1.0	74.0

¹ Unpublished data, 5,000 tests.² Cited from Race and Sanger ('50, p. 50).³ In the Negro series 580 bloods were tested for their M-N-S types.⁴ Miller, Tannor and Hsu ('50).⁵ Wiener and Gordon ('49).⁶ Sanger, Bertinshaw, Lawler and Race ('49).⁷ Levine, Wigod, Backer and Ponder ('49).⁸ Cutbush, Mollison and Parkin ('50).

results compared with the data obtained by the British workers (cf. Race and Sanger, '50, p. 50).

NO. TESTED	PRESENT STUDY 200	ENGLISH STUDIES 1419
M.S	22.0%	20.8%
M.s	8.5%	7.5%
MN.S	27.0%	26.7%
MN.s	23.0%	22.7%
N.S	8.0%	7.2%
N.s	11.5%	15.1%

The above figures would seem to corroborate the specificity of our sera. The higher than expected rate of S positives among MN bloods might have entirely been due to chance. To lessen the likelihood of this a second series of 380 Negro bloods were tested. In this latter series many bloods were also tested with two examples of natural anti-M sera of human origin which clearly showed dosage effect. The results obtained for the first and second series were essentially the same. The figures given in table 1 for the M-N-S testing in Negroes are for 580 individuals. The apparent discrepancy in the percentage of S positives among MN bloods in Negroes is being further investigated by family studies.

The interesting feature is that the M-N blood types which are fairly similar for the three racial groups concerned, are markedly different when further classified by the anti-S serum. This becomes more evident when the data are presented in still another way.

	CAUCASIANS	CHINESE	NEGROES
	%	%	%
M bloods S+	73.4	10.0	28.6
MN bloods S+	54.1	13.3	33.3
N bloods S+	32.3	5.6	23.0
All bloods S+	54.7	10.7	29.5

P factor. The P factor was present in the bloods of 27.2% of the Chinese and 95.0% of Negroes. This compares favorably with the figures of 32.6 and 98.3% previously found in

larger studies (Miller, Tannor, and Hsu, '50). The incidence of the P factor among Caucasian bloods has varied between 73 and 81% with most authors finding about 75%.

Rh-Hr system. As in other Asiatic groups, the frequency of Rh positives in the Chinese is very high. With the exception of two bloods, all specimens belonged to the types Rh₁, Rh₁Rh₂, or Rh₂. All the type Rh₁Rh₂ bloods reacted with the hr' antibody; hence, no examples of type Rh₂Rh₁ were discerned. In other populations with high incidence of Rh positives, Wiener et al. ('45) found a relatively high frequency of 3% of the gene R^z in Mexican Indians, and Simmons et al. ('46, '48) 3 to 6% in Papuans and Australian aborigines. Type Rh₂Rh₁ was also not encountered in the Negro series.

Variants of the Rh factors. The anti-Rh₀ serum used in this study contained a very potent saline agglutinin ordinarily giving very marked clumping. Occasional bloods were encountered which gave distinctly weaker reactions and these were classified as weakly reacting Rh₀ factors, intermediates (Wiener, '44), D^u (Stratton, '46), or variants of Rh₀. In addition, all bloods giving negative reactions with the anti-Rh₀ serum, were incubated with two incomplete Rh₀ anti-sera and then tested with anti-globulin serum. Additional variants of Rh₀ were discovered in this way. In the Chinese series no variants of the Rh₀ factor were encountered. However, among Negro bloods there were 11 weakly reacting Rh₀ factors; 5 as Rh₁, 2 as Rh₂, and 4 as Rh₀. Previously (Miller, Tannor, and Hsu, '50), we had found 9 weakly reacting Rh₀ factors among 200 Negro bloods, which compares well with the 5.5% frequency in the present series. The incidence of weak reactions in testing for the Rh₀ factor in Negroes is about three times that in Caucasians (Rosenfield, Vogel, Miller, and Haber). The use of the anti-globulin test in Rh₀ typing probably accounts for the higher incidence of the Rh₀ subtype and lower incidence of the rh and rh' subtypes in our series as compared with the data of Wiener and Gordon ('49). Wiener, Unger, and Sonn ('45) first pointed out the high frequency of weakly reaction Rh factors in Negroes.

Weakly reacting rh' and hr' factors were occasionally found among Negro bloods, while only one example of weakly reacting rh' was encountered in the Chinese.

Kell-Cellano (K-k) system. Not a single Chinese blood reacted positively with the anti-Kell serum while 3.5% of the Negro bloods were sensitized. This is in contrast to the incidence of 10.2% Kell positives in Caucasians (Sanger, Bertinshaw, Lawler, and Race, '49). A number of bloods in each series were tested with the anti-Cellano serum, and all specimens tested gave positive reactions.

Duffy (Fy^a) factor. The racial differences in respect to this antigen were very striking. All but one Chinese blood was sensitized by the anti-Fy^a serum while among the Negroes only 26.0% of the samples gave positive reactions. Cutbush, Mollisin, and Parkin ('50) found 66% of the Caucasian bloods contained this agglutinin.

Lewis system. This system of human blood factors has a number of unique features. Most of the examples of anti-Le^a sera that we have encountered have been mixtures containing smaller amounts of another agglutinin, probably anti-Le^b. In the anti-serum used in this study, the group agglutinin was successfully absorbed while a trace of Le^b antibody remained. The anti-Le^a agglutinin had a wide thermal range of activity but with the best avidity at lower temperatures. However, the tests were performed at room temperature in order to minimize the effect of the remaining Le^b antibody. The anti-Le^b serum did not contain Le^a antibodies. Both Lewis anti-sera came from A₁ donors lacking the Lewis factors in their red cells. The Lewis anti-sera when fresh and prior to inactivation, had the property of hemolyzing as well as agglutinating red cells at 37°C., especially when trypsin treated cells were used. With aging or inactivation only clumping was exhibited. The anti-Le^b serum was active at various temperatures, the best avidity appearing at lower temperatures. This was particularly true for many A₁ bloods. The tests were carried out at 14–16°C.

In table 2 are listed the results of testing the *adult* bloods of the various racial groups with the two types of Lewis anti-sera. The findings of Andresen ('48) are also given. He ('47) found that in adults the Le^a antibody agglutinates only those bloods homozygous for this factor. However, occasional bloods reacted with both sera. This finding is to be taken with reserve in view of the presence of a second

TABLE 2
Reactions of bloods to the Lewis anti-sera

RACIAL GROUP	SELECTION	NO. TESTED	$Le^a +$ $Le^b -$	$Le^a +$ $Le^b +$	$Le^a -$ $Le^b +$	$Le^a -$ $Le^b -$
Caucasians Present study	All group O	300	22.3	1.0	72.3	4.3
Caucasians Andresen	All group O	238	20.0	0.0	74.0	6.0
Caucasians Present study	None	160	23.8	0.6	67.5	8.1 ¹
Caucasians Andresen	Groups A_1 , A_2 and O	525	20.0	1.5	57.1	21.4
Chinese Present study	None	85	23.5	1.2	69.4	5.9 ²
Negroes Present study	None	200	23.0	1.0	60.0	16.0 ³

¹ Nine of 13 were A_1 .

² Three of 5 were A_1 .

³ Four of 32 were A_1 .

antibody in the Le^a serum.¹ The anti- Le^b serum apparently reacts with those bloods either homozygous or heterozygous for this factor. A certain number of bloods fail to react with either of the sera. While this phenomenon is more usual in the cases of A_1 bloods it is occasionally seen in bloods of other groups. Andresen offered two suggestions in an attempt to explain this. (1) Certain bloods, particularly those containing the A_1 factor exert a partial or complete suppressing effect

¹ Subsequent studies with Lewis antisera have failed to reveal bloods reacting with both anti- Le^a and anti- Le^b and it may be presumed that those encountered in this study were Le^a - Le^b +.

on the Le^b agglutinin (epistasy). (2) A third allele exists in this system of genes. The evidence for the first is found in the actual testing. Evidence for the second suggestion comes from the fact that many anti- Le^a sera contain smaller amounts of another antibody, presumably anti- Le^b . We have searched for the antibody for this postulated third allele (Le^c) by using the red cells from a donor whose serum contained anti- Le^b and whose red cells were not clumped by either Lewis anti-serum. The sera of about 1500 individuals of the appropriate blood group were tested against these red cells with negative results.

Grubb ('48) and later Race et al. ('49) found that all Le^a positive bloods were derived from non-secretors of A-B-O substances and that almost all persons whose bloods were Le^a negative were A-B-O secretors. In view of the high degree of correlation between genes Le^a and s (non-secretor of A-B-O substances), Grubb and Morgan ('49) raised the question whether these genes were closely or completely linked. Determination of secretor status was not performed in this study. The results of testing the Chinese bloods with the Lewis anti-sera could have been anticipated, for while data on the secretor factor are not available for this group, in Japanese (cf. Wiener, '43) the secretor rate is similar to that in Caucasians. Our results for Negroes were surprising. Schiff ('40) found non-secretors to be almost twice as frequent in Negroes as in Caucasians. In the present study, the frequency of Le^a positive bloods in both racial groups was about the same. However, the number of Negro bloods failing to react with either Lewis antibody was very high despite the low incidence of the A_1 factor. Should many of the Le^a - Le^b bloods be derived from non-secretors of A-B-O substances then the frequency of Le^b positives and secretors would approximate each other as expected.

SUMMARY

Tests were performed on 103 samples from presumably full-blooded Chinese, predominantly Cantonese in origin, and

200 Negroes, all residents of New York City. For the older blood group systems our data confirm the previous findings of others. The B factor has a higher frequency in Chinese and Negroes than in Caucasians. The A_2 factor was not encountered in Chinese while it is more common among group A bloods in Negroes than in Caucasians. The M factor may be somewhat more frequent in Chinese (Cantonese) and less frequent in Negroes than in Caucasians. The P factor is almost universal in Negroes while in Chinese its incidence is low. In both racial groups the frequency of Rh positives is high. Weakly reacting variants of Rh_o , rh' and hr' factors in Negroes are comparatively frequent but are unusual in Chinese. The phenotype Rh_zRh_1 was not encountered in either series.

With regard to the newer agglutinins, original observations have been made. The S and K (Kell) factors are lower in Negroes as compared to their incidence in Caucasians. In Chinese they are markedly diminished. The Fy^a (Duffy) factor is almost universal in Chinese and rather low in Negroes. The Lewis factors (Le^a and Le^b) are similar in Chinese and Caucasians. In Negroes the frequency of Le^a positives is similar to that in the other two racial groups. However, the incidence of bloods failing to react with either Lewis agglutinin may be significantly higher in Negroes.

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STUDIES ON THE A-B-O, M-N, AND R_H-H_R BLOOD
FACTORS IN THE DOMINICAN REPUBLIC,
WITH SPECIAL REFERENCE TO THE
PROBLEM OF ADMIXTURE

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Does the mestizo exist in our country? This question came to my mind as a result of a meeting in one of our hospitals, at which the interne, on mentioning a patient's race, would classify some as mulattoes and others as mestizos. I asked him why he made that distinction since the word "mestizo" refers expressly to a mixture of White and Indian; he answered that it was customary to do so in the national hospitals. This answer did not satisfy me; what I really wanted to know was what racial characteristics were used to classify some as mestizos and others as mulattoes. The interne evidently wished to indicate that there are notable differences among the Dominican mulattoes, or rather that there are two kinds of mulattoes in the Dominican Republic. The first kind is the "pure" mulatto with manifest Negroid characteristics where there can be no question about using the label "mulatto." The second kind comprises lighter or darker skinned peoples with very straight black hair, high and pronounced cheekbones, prominent physiognomical features, with hardly detectable Negroid features, so that it seems improper to classify them as mulattoes. This is why the term "mestizo" is used to refer to the second group in our hospitals, but without implying that the lack of Negroid features is due in any way to mixture with Indians.

To put the question differently: Is admixture with Indians really responsible for the peculiar characteristics of the sec-

ond group, and is the term "mestizo" correctly applied; or is it a greater or smaller percentage of mixture with Whites which makes the two groups differ, in which case the term "mestizo" would be incorrectly applied, This anthropological problem I propose to solve in this paper by analyzing the distribution of blood group factors among Dominicans.

HYPOTHESIS

We may assume from the mortality rates as given in the 1940 Statistics Annual of the Dominican Republic that the ethnic groups are distributed as follows:

Mulattoes	—	77%
Negroes	—	12%
Whites	—	11%

The 1935 Census gives similar statistics. As we see from these data the Dominican population is made up of a larger group of mulattoes with smaller groups of "pure" Negroes and Whites.

Two reasonable hypotheses suggest themselves to account for the differences between mulattoes and mestizos.

First hypothesis. The Spanish Conquistadors completely annihilated the aborigines without mixing with them, only to mix later with the imported Negroes to form a simple mixture of Negro and White, which makes up the great mass of mulattoes observed in our country today. This is the hypothesis generally accepted by modern historians, who consider that at present there exist no remnants of the Indian aborigines. Under this hypothesis the differences in skin color are due to different degrees of White-Negro mixture. For example, Rodolfo Baron Castro ('45) maintains this position.

Second hypothesis. The Spanish Conquistadors mixed with the Indians to a degree unknown to us, forming a mestizo population, which later crossed with the African Negro to give rise to a trihybrid mixture. According to this hypothesis, the bulk of Dominican mulattoes resulted from a cross between Spaniards and Negroes with some degree of Indian

admixture, and with smaller distinct groups of "pure" mulattoes and mestizos. That would explain why there is such a range of skin colors in our country, and the resulting ethnic groups may be classified as follows:

"Pure" negro
"Pure" mulatto
Mulatto-mestizo
Mestizo
White

The "pure" mulatto is defined as a simple cross of White and Negro. The "mulatto-mestizo" group is a mixture of the three races, White, Negro, and Indian, with varying proportions of each. In the ethnic group called "mestizo" the mixture of White and Indian predominates resulting in certain physical characteristics which enable a careful observer to detect the indigenous background.

In my work on paternity investigations using the blood groups and Rh factors in 1948, I suggested the second hypothesis for the first time. In this paper I propose to demonstrate the presence of the Indian component through a study of the blood group factors.

*Theoretical basis of the application of blood
grouping in anthropology*

The first investigation on the racial distribution of blood groups was made by L. and H. Hirszfeld. Physicians in the Allied Armies in Salonica, Greece, during the First World War, they took advantage of the presence of troops and prisoners of war of many nationalities (and the native populations) to undertake an investigation of blood groups of different races, taking blood samples from 500 to 1,000 individuals of each nationality. By this means, they showed that the 4 Landsteiner groups occur in all races, but that their frequencies differ for each country (or ethnic group). After the work of L. and H. Hirszfeld, investigations on the distribution of blood groups were carried out in nearly all of the countries of the world.

Depending on the distribution of 4 blood groups Ottenberg has classified peoples in 6 categories.

	APPROXIMATE FREQUENCY OF BLOOD GROUPS		
	O	A	B
I. European	39	43	12
II. Intermediate (Arabs, Turks, Russians, etc.)	40	33	20
III. Hunan (Japanese, Southern Chinese, Hungarians, Rumanian Jews)	28	39	19
IV. Indo-Manchurian (Koreans, Northern Chinese, Gypsies, Hindus, Manchurians)	30	19	39
V. Afro-South Asiatic (Negroes, Malayans, Indo-Chinese, Madagascar)	42	24	28
VI. Pacifico-Americans (American Indians, Australian aborigines, Filipinos, Oceanians, Icelanders)	67	29	3

The discovery of the blood factors M and N and, above all, of the Rh blood types has greatly enhanced the value of anthropological studies by means of blood group factors. For the Rh types fundamental differences among different races have been found; for example, the type Rh₀ is found in about 40% or more of Negroes, while in the Whites and Mongoloids its frequency ranges between only 1 to 3%. Among Whites the highest proportion of Rh-negative persons is found, and the type Rh₁ is found in abundance. In the Mongoloid group there is a virtual absence of Rh-negative individuals and the highest frequency of the rare gene *R^z*.¹

Ottenberg's racial classification, based only on the A-B-O system, yields artificial results, not conforming with other anthropological evidence. Lahovary, making use in part of the M and N factors and occasionally of other factors besides Landsteiner's classic groups, proposed still another classification into 8 divisions: European, Mediterranean, Mongolian, African, American Indian, Oceanian, Indonesian, and Polynesian.

¹ Italicized symbols stand for genes as opposed to agglutinogens or blood groups.

Wiener ('46b), combining information recently acquired regarding the Rh blood types and the subgroups of A with that already known about the A-B-O groups, proposes the following racial classification.

I. *Caucasoid*. The characteristics of this group are the highest frequency of the gene r , the relatively high frequency of genes R^1 and A^2 , and moderate frequencies of the other blood group genes.

II. *Negroid*. Highest frequency of gene R^0 , moderately high frequency of gene R^1 , relatively high frequency of gene A^2 and of the rare intermediate A and Rh genes.

III. *Mongoloid*. Virtual absence of gene r and A^2 , and highest frequency of the rare R^2 gene.

This, according to Wiener, has permitted the solution of certain anthropological problems. For example, the Australian arborigines, whom Ashley Montagu ('45) places in an intermediate 4th group between the Negroid and Causasoid, and Papuans, whom he places in the Negroid group, were shown by Wiener ('46b) to belong more appropriately in the Mongoloid group, according to the results of tests for the Rh-Hr types and subgroups of A. Wiener's classification, besides being in perfect accord with fundamental anthropology, has the advantage that it is based on well determined characteristics and substantiated differences among the races. Nevertheless, it would seem convenient to classify the human species into more than three subdivisions. Wiener, himself, with the information given by the M and N factor subdivides the Mongoloid group into Asiatic, Pacifico-Australian and Amerindian-Eskimo groups.

In his recent book, Boyd ('50) breaking with traditional anthropology, which classifies mankind on the basis of external phenotypic characteristics, proposes a racial classification based on modern concepts of human genetics, which differs only slightly from that proposed by Wiener just described. Boyd's classification is as follows:

"I. Early European group (hypothetical) — Possessing the highest incidence (over 30%) of the Rh-negative type (frequency of

gene rh greater than 0.6), and probably no group B. A relatively high incidence of the genes Rh_1 and A_2 . Gene N possibly somewhat higher than in present-day Europeans. Represented today by their descendants, the Basques.

"II. European (Caucasoid) group — Possessing the next highest incidence of rh (the Rh-negative gene), and relatively high incidence of the genes Rh_1 and A_2 , with 'normal' frequencies of M and N , i.e., $M = \text{ca. } 30\%$, $MN = \text{ca. } 49\%$, $N = \text{ca. } 21\%$.

"III. African (Negroid) group — Possessing a tremendously high incidence of the gene Rh^0 , a moderate frequency of rh , relatively high incidence of genes A_2 and the rare intermediate A ($A_{1.2}$, etc.) and Rh genes, rather high incidence of gene B. Probably 'normal' M and N .

"IV. Asiatic (Mongoloid) group — Possessing high frequencies of genes A_1 and B , and the highest known incidence of the rare gene Rh^z , but little if any of the genes A_2 and rh (the Rh-negative gene). Normal M and N . (It is possible that the inhabitants of India will prove to be an Asiatic subrace, or even a separate race, but information is still sadly lacking.)

"V. American Indian group — Possessing varying (sometimes high, sometimes zero) incidence of gene A_1 , no A_2 , and probably no B or rh . Low incidence of gene N . Possessing Rh^z .

"VI. Australoid group — Possessing high incidence of gene A_1 , no A_2 , no rh , high incidence of gene N (and consequently a low incidence of gene M). Possessing Rh^z ."

It is not necessary to make a comprehensive analysis of the blood groups of different peoples to prove my thesis; it is only necessary to examine the distribution of the blood factors and groups among Caucasoids (especially the Spanish), the African Negro, and the American Indian aborigines, because the Dominican population had its origin in those three races. Later immigrations are of negligible importance since all attempts to attract immigrants have failed. The only one of any consequence, the Arabian immigration of the late 19th Century, has not yet mixed with the native Dominican population sufficiently to have any noticeable effect.

Before entering into the comparative analysis of the blood groups of White, Negroes, American Indians, and Dominicans, it is necessary to clarify several principles of blood group genetics which are indispensable for the demonstration

of my thesis. Above all, the inheritance of blood groups is not influenced by environment. For example, the Jews of Macedonia, who have lived there since the 15th century, have a blood group composition which is different from other inhabitants of the Balkans. Also, the serological composition of the gypsies (of Hungary), who through 5 centuries have preserved their language and customs, does not differ appreciably from that of the natives of India from whom they came, but is different from that of the Hungarians. A German colony in Hungary, which emigrated in the 18th century and which has maintained itself without mixing with the Hungarians, has the same serological composition as other Germans.

Another advantage of using blood groups in anthropology is that mating takes place at random; that is, no one, when marrying, takes into consideration the partner's blood group. The same does not hold for external physical characteristics; for example, a tall person is more likely to marry another tall person than a short person.

As Bernstein has shown and Wiener ('43) notes, if it is known that a given population resulted from a mixture of two other peoples and the distributions of the blood groups in the original peoples are also known, then one can calculate the proportion of individuals from each race which took part in the cross. For example, Wiener ('43) was able to estimate the degree of mixture with Whites of Indian mestizos in the United States. Similarly, an increase of a blood factor in a population indicates mixture with another ethnic group; e.g., the high frequency of group B in the Germans is attributable to mixture with the Slavic peoples, and the high frequency of type Rh₀ among Puerto Ricans, according to Wiener, indicates mixture with Negroes. Applying the same principles we shall demonstrate that the high frequencies of group O, type M, and type Rh₁Rh₂ in the Dominican population establishes mixture in the past with the aborigine Indian.

Another fact shown by the science of genetics (see Stern, '49, ch. X) is that, when two populations mix, equilibrium

in the distribution of characters determined by allelic genes is established in the mixed population after a single generation of random mating, and that this equilibrium persists indefinitely, unless some new racial admixture changes it. This law was discovered independently by the mathematician Hardy and the physician Weinberg in 1908. This accounts for the establishment of a definite distribution of the blood groups in a hybrid population, a distribution which remains unchanged and permits us to determine by testing the blood of the present-day population the influence of a race which disappeared 400 years ago.

RESULTS

These principles settled, let us analyze the results obtained by blood examinations, using the A-B-O, M-N, and Rh-Hr systems of blood factors.

First 320 randomly selected, unrelated Dominicans were tested in order to establish the average distribution of the blood factors in the Dominican population in general, without regard to race. For this purpose, only Dominicans whose great grandparents were Dominicans were chosen. Then I took 100 individuals whose external physical characteristics are those of the "pure" mulatto, and 100 whom I would classify as mestizos, that is, whose physical traits suggest the possibility of mixture with Indians. In the latter study, I have had the collaboration of Drs. Fred W. Lithgow and José J. Jimenez, who provided me with blood samples of people whom they classified as mestizos.

For the A-B-O groups, I have used various statistics published in the Dominican Republic, the first made by Dr. Angel M. Ponce Pinedo, under the direction of Dr. Hector Read — 2100 cases — in 1941; the second by Dr. Rogelio Baron Castro — 4980 cases — in 1943-1944; and the third by Dr. José V. Fernandez Sanches — his doctor's thesis in 1948. In no case have these workers taken into consideration the racial characteristics of the persons examined. In addition, Dr. Fernandez Sanches has obtained for me various studies made

TABLE 1

Distribution of the A-B-O groups and Rh factors in the Dominican Republic

INVESTIGATOR AND YEAR	LOCALITY	NUMBER OF INDIVIDUALS EXAMINED	BLOOD GROUPS (%)				Rh FACTOR (%)	
			O	A	B	AB	Rh +	Rh -
Angel Ma. Ponce Pinedo ¹ 1941	S. P. de Macoris	2100	52.9	28.2	15.7	3.2		
Rogelio Cordero Castro 1944 (Doctor's thesis)	Trujillo	4980	52.7	31.9	12.2	3.2		
José V. Fernandez 1948 (Doctor's thesis)	Santiago	250	54.0	28.0	12.0	6.0		
José de Js. Alvarez 1950 (Present study)	Santiago	400	50.25	34.50	11.0	4.25	89.13	10.87
	Northwest Boundary, Monto Cristi, Dajabon, etc.	432	51.1	31.2	14.8	2.9	88.90	11.10
	Trujillo (Soldiers)	294	53.8	32.3	11.2	2.7	95.90	4.10
	South-Bahoruco, Neyba, Jimani, Pedernales	569	53.6	24.8	16.9	4.7	87.90	12.10
	Puerta Plata (Soldiers)	59	62.7	25.4	6.8	5.1	100.0	0
General average		9084	52.75	30.50	13.34	3.41		

¹ Revista de la Cruz Roja Dominicana, '41.

TABLE 2
The A-B-O blood group system

NATURE OF SAMPLE	NUMBER OF INDIVIDUALS EXAMINED	PHENOTYPES (%)				GENE FREQUENCIES (%)			$p + q + r$	DEVIATION FROM 100%
		O	A	B	AB	r	p	q		
Dominicans (general average)	9,084	52.75	30.50	13.34	3.41	72.62	18.56	8.68	99.86	- 0.14
Dominican Mestizos ¹	100	54	32	11	3	73.48	19.40	7.30	100.18	+ 0.18
Dominican Mulattoes ¹	100	48	33	16	3	69.28	20.00	10.00	99.28	- 0.72
Spaniards ²	50,791	38.2	47.2	10.1	4.5	61.74	30.19	7.60	99.52	- 0.48
Negroes	General average	46.8	25.4	23.4	4.4	68.41	16.11	15.01	99.53	- 0.47
American Indians	Hypothetical	100	0	0	0	100	0	0	100	...
First hypothesis: Simple mixture of Whites and Negroes		42.5	36.3	16.75	4.45	65.19	22.86	11.20	99.25	- 0.75
Second hypothesis:										
Whites 40%		52.4	29.8	14.3	3.5	72.32	18.25	9.31	99.88	- 0.12
Negroes 43%										
Indians 17%										
Deviations for the first hypothesis of gene frequencies						7.43	4.30	2.56		
Deviations for the second hypothesis of gene frequencies						0.30	0.31	0.63		

¹ Present investigation.

² After de Hoyos Sainz ('47).

by Army doctors in different parts of the country. In table 1 these data are shown by region, and the data have also been combined into a total of 9084 individuals tested by the different investigators in different parts of the country, thereby arriving at a general average for the Dominican population.

TABLE 3
The M-N system

NATURE OF SAMPLE	NUMBER OF INDIVIDUALS EXAMINED	PHENOTYPES (%)			GENE FREQUENCIES		
		M	N	MN	m	n	m + n
Dominicans (Present study)	320	40.0	18.66	41.34	63.25	43.25	106.5
Dominican mestizo (Present study)	100	48	15	37	69.30	38.70	108.0
Dominican mulattoes (Present study)	100	32	25	43	56.60	50.00	106.6
Spaniards (Boyd, '50)	134	26.9	17.9	55.2	51.87	42.31	104.1
Negroes (New York) (Landsteiner — Levine, Wiener) ¹	278	28.42	21.94	49.64	53.20	46.80	100.0
Navajo Indians (Boyd, '50) (New Mexico)	361	84.5	1.1	14.4	91.87	10.49	102.1
First hypothesis		27.66	19.92	52.41	52.54	44.61	97.1
Second hypothesis		38	18	44	61.24	42.43	103.6
Deviations for the first hypothesis of gene frequencies					10.71	0.36	
Deviations for the second hypothesis of gene frequencies					2.01	0.82	

¹ Blood groups and transfusion (Wiener, '43).

For the M-N types, the only data previously published are those included in my work on disputed paternity. The number of individuals tested is now greater and to date I have examined 520 persons for these blood factors. The results are summarized in tables 3 and 4. (I have had to test the blood

TABLE 4
The Rh blood types

NATURE OF SAMPLE	NUMBER OF INDI- VIDUALS EXAMINED	Rh BLOOD TYPES (%)						rh'	rh''	rh'rh''
		Rh ₀	Rh ₁	Rh ₂	Rh ₁ Rh ₂	rh				
Dominicans (Present study)	320	20.0	44.2	10.9	14.03	10.0		0.87	0	0
Dominican Mestizos (Present study)	100	15	45	8	21	10		0	0	0
Dominican Mulattoes (Present study)	100	28	40	13	7	10		2	0	0
Spaniards (Boyd, '50)	223	0.5	63.2	13.0	9.4	13.0		0	0.5	0
Negroes (N.Y.C.) (Wiener et al. ['44])	135	45.9	23.7	16.3	4.4	7.4		1.5	0.7	0
American Indians (pure) (Wiener et al. ['45])	95	1.1	48.1	9.5	38.1	0		0	0	0
Expected distribution under first hypothesis (White-Negro mixture)		23.2	43.4	14.7	7.0	10.2		0.8	0.6	0
Expected distribution under second hypothesis Negro 43% White 40% Indian 17%		20.2	43.8	13.7	12.4	8.5		0.7	0.5	0

of each person myself, in my private laboratory, and for that reason it has been impossible to carry out a more imposing number of examinations.)

Let us consider the serological characteristics of the peoples who give rise to the Dominican population, that is, the White (or Spanish), the Negro, and the American Indian. Based on the calculations of Wiener, Dujarric de la Riviere and Kossovitch, the characteristics of these races are as follows: In the Spanish there is a high frequency of group A (46 to 51%), a low proportion of group B, while group O is slightly above 40%. These are, for the most part, the characteristics of the peoples of Western Europe; group A diminishes from West to East in Europe, and the proportion of group B increases as one approaches Asia. Negroes possess a high B component (in comparison with Spaniards) with approximately 20 to 29% belonging to that blood group, a low proportion of group A, and about 45% of group O. On the other hand, the American Indian is characterized by a very high percentage of group O (primitive Central and South American Indians belong almost exclusively to this blood group). For the M-N types, the proportions in Whites and Negroes differ little, while in the American Indian we find a high proportion of M and a low proportion of N.

For the Rh types the findings are very different for each racial group. Type Rh₀ is relatively rare in Whites, who have a high proportion of type Rh₁, and a percentage of type rh (Rh-negative) higher than the other two races. American Negroes (Wiener et al., '44) are characterized by a high percentage of type Rh₀,² about 40%, with less type Rh₁ and type rh than Whites. The American Indians, on the other hand, have a high percentage of type Rh₁Rh₂, between 38 to 53%, while types Rh₀ and rh are rare.

Thus, the three peoples who may have formed the Dominican population have very different serological characteristics. High percentages of group A, types Rh₁ and rh, and low percentage of B characterize the Whites; the Negro has a

² In Africa, no doubt, the frequency of type Rh₀ is even higher.

high proportion of group B, type Rh₀, and lower proportion of group A. These two races have properties M and N in similar proportions. The serological properties of Indians are a high frequency of group O, high proportion of type M, type Rh₁, and type Rh₁Rh₂, with a virtual absence of type rh.

For the comparative study, the distribution of the blood group factors in the races in which we are interested are listed in tables 2, 3, and 4. On the 7th line of these tables are given the distribution to be expected in a population resulting from a mixture of Whites and Negroes, without any outside mixture, according to the first hypothesis, which is the one favored by our contemporary historians. On the 8th line of these tables are given the figures which would be obtained if we mixed three races, Negro, White and Indian in proportions 43%, 40%, and 17% respectively, which is the hypothesis that I maintain. The blood group distribution of Dominicans may be compared with the figures given by these calculations, and it will be observed that the findings which were to be expected according to the second hypothesis are strikingly similar to those actually found in the Dominican population.

Let us now analyze the results obtained in the Dominicans in relation to the blood group distributions of the original races. In the statistics given for the Landsteiner A-B-O blood groups among 9084 Dominicans, the first thing which attracts one's attention is the high proportion of persons which belong to group O. Obviously, if the component races were only White and Negro, the percentage of group O among Dominicans could not exceed 45%, because that percentage is not exceeded by either of these races. But in Dominicans we find 52.75% group O which indicates the presence of a hidden element from some other race, with a high frequency of group O. The aborigines had precisely that characteristic. On the other hand, the percentage of group A might be expected to be greater due to the high percentage of this group in Spaniards; but the same factor which raises the percentage of group O does not permit a high proportion of group A. The results obtained from the group of individuals labelled

as mestizos confirm this hypothesis, for here there is an even higher proportion of group O. In the "pure mulatto," on the other hand, group O is lower and group B is higher due to the greater mixture of Negroes.

As already mentioned, the distribution of the M-N factors is similar in Negroes and Whites. Accordingly, a mixture of these two races should give about the same proportion of these blood types. However, while type M has a frequency of 30% in Whites and Negroes, in Dominicans the frequency is about 40%, indicating mixture with a race having a higher frequency of this blood type, namely, the Indian aborigines. An examination of the Dominican "mestizo" and "mulatto" confirms the second hypothesis, because the mestizo has a still higher percentage of type M, while the mulatto has a percentage of type M approximately equal to that of Negroes and Whites due to a virtual absence of Indian admixture. The frequency of gene *M* among Spaniards is 51.87% and among Negroes 53.20%, while among the American Indians (using statistics for the Navajo of New Mexico from Boyd's book, which is the most complete which I can find for these factors) it is found in 91.87%. The gene occurs in the Dominicans with a frequency of 63.75% which is considerably higher than the value for Spaniards and Negroes, clearly indicating mixture with a race such as the American Indian, having a high frequency of gene *M*.

With regard to the Rh factors, type Rh_1Rh_2 is found in the Dominicans as a whole in proportion of 14%, but the frequency varies from 21% in the group classified as "mestizo" to 7.5% in the group classified as "mulatto." As has already been pointed out, a high frequency of type Rh_1Rh_2 is a characteristic of Mongoloids and American Indians, in whom it is found with a frequency of 38 to 53%, while, in contrast, Spaniards (again referring to Boyd) have an incidence of 9.4% of this type and Negroes 4.4% to 7%. Here again the results suggests mixture with the aborigines; a simple White (Spanish) Negro mixture would give a figure

close to 7%, while as just pointed out the actual frequency is 14%.

In short, therefore, the high frequencies of group O, type M, and type Rh₁Rh₂ in Dominicans indicate the presence in our country of an Indian component as well as a mixture of Whites and Negroes. This does not seem extraordinary when one considers the biological probabilities of the Spanish Conquistadors having mixed with the aborigines.

Let us now examine tables 2, 3, and 4 further. One observes that type Rh₀ is found in 20% of the Dominicans, a figure which indicates a high percentage of Negroid admixture, in conformity with the physical characteristics of our people. If the original Negroid ancestors had a type Rh₀ percentage of 45.9, the Spanish 0.5%, and the Indians 1.1%, then by applying Bernstein's calculations one finds that the figure of 20% for the Dominicans indicates that the negroid component makes up approximately 43% of the population. This same percentage is obtained from calculations with the frequencies of q and p . What makes up the remaining 57%? According to our historians it should be the White race, but in that case we would expect 44% of group O instead of 53%, 38% of group A instead of the 30% actually found, and 30% of type M instead of 40%. For the Rh types there should be less type Rh₁Rh₂. Thus, none of the results obtained support the first hypothesis.

Let us now test the second hypothesis, which I maintain. According to this hypothesis the remaining 57% is made up principally of Spanish but with a small proportion of American Indian in addition. Calculations based on the frequency of the blood groups in the Dominican population indicate the proportions to be 40% Spanish and 17% Indian. For the A-B-O system, data are available for a total of 9084 individuals, a series large enough to make possible reliable conclusions in spite of the statistical error. Let us compare the actual findings with those to be expected for a population resulting from a mixture of 43% Negro, 40% Spanish, and 17% American Indian:

	O	A	B	AB
Results obtained for 9084				
Dominicans examined by various investigators	52.75	30.50	13.34	3.41
Distribution for a population resulting from a mixture of 43% Negro, 40% Spanish, and 17% Indian	52.40	29.80	14.30	3.50

It is apparent that the calculations made according to the second hypothesis agree closely with the actual results obtained from the 9084 examinations. The results obtained for the M-N types and Rh types serve further to confirm my hypothesis that there does exist an Indian component in the Dominican population.

In table 2 is given the deviations of the frequencies p , q , and r for the first and second hypothesis. For the first hypothesis (simple White and Negro mixture) the deviation for gene r is 7.43%, for p 4.30%, and for q 2.56%, while for the second hypothesis the deviations are only 0.30, 0.31, and 0.63, respectively, none of which is significant when one takes into account the statistical error. For gene M , the deviation under the first hypothesis is 10.71 and under the second only 2.01.

Further evidence of the continued existence of an aborigine element is the Dominican "mestizo." Were the mestizo merely the result of a higher proportion White ancestors mixed with the Negro, then one would expect 44% of group O instead of 54%, 42% of group A instead of 32%, 30% of type M instead of 48%, while type Rh_1Rh_2 could never approach 21%. The higher proportion of O, M, and Rh_1Rh_2 in the Dominican "mestizo" are merely a sign of its higher proportion of the Indian component. On the other hand, the figures obtained for the "pure mulatto," where the mixture with the Indian has been very slight, shows that my reasoning has been correct because one finds lower frequencies of O, M, and Rh_1Rh_2 , and higher frequencies of B and Rh_o . It is significant that

for each of the three systems of blood groups, which are inherited independently, the findings indicate presence of admixture with the aborigine, and that this influence manifests itself most in the group which exhibit external physical traits considered characteristic for Indians. If this were due entirely to chance, one would expect to find discrepancies between the results for the different systems of groups and in the different ethnic types.

*Blood type distribution in different parts
of the Dominican republic*

The figures which I have calculated for the percentages of White, Negro, and Indians which crossed to produce the present population of the Dominican Republic are not absolute, but approximate figures which serve to fix certain concepts. To state simply that aborigine admixture exists in our country might suggest a higher percentage than is actually present. It must be emphasized that the calculated percentages refer to the Dominican population taken as a whole. This does not mean that the same proportions exist in all parts of the country. In urban areas, where people have come from all regions, and where the different types are continually mixing, there are very low proportions of Indian admixture. Moreover, there are parts of the country where there is no evidence of Indian mixture, due to the ease with which the Conquistador was able to drive out the Indians, and due to the continual importation of (first) African slaves and (second) of Haitian and British West Indian Negroid farm workers. This is true, for example, of the regions of the sugar plantations in the South and East. It is in the mountainous and other regions not easy to reach, where the aborigines were able to isolate themselves, that the highest percentage of Indian blood is found. Everyone who is familiar with our mountainous regions has had the opportunity to notice that the natives there show very definite Indian physical characteristics.

Consult table 1 again and observe how the distribution of the blood groups and the racial characteristics of the inhabitants of each region coincide. Above all, look at the statistics supplied by Ponce Pinedo, from San Pedro de Macoris. These show a decrease of group A and an increase of group B, indicating a greater influence of the Negroid race in this region. This is explained by the long standing custom of the sugar plantations of this region to import Negroid workers. The statistics of Rogelio Cordero Castro, for Ciudad Trujillo, really do not represent the population of that city but of the entire country at large since they include examinations of members of the National Army. That is why these results are almost the same as the general average of the Dominican population. The same applies to the data of Dr. Fernandez. In the group examined in the Province of Santiago by the author, there is a noticeable increase of group A and decrease of group B, which reveals a higher percentage of White blood in this region — a fact which is supported by observation of the physical characteristics of these individuals.

In the statistics for the Northwest and Bahoruco, regions bordering on Haiti, one observes an increase of group B due to the influence of the neighboring Negroid race. Another interesting result is that obtained in Bahoruco, the last stronghold of the native Indian. In this region we find 53.5% of group O, a figure almost equal to that obtained by me for the group which I classified as "mestizo," but we find a great difference between the A and B groups of the two groups of people. In the mestizo, I found 32% of group A and 11% of group B, while in Bahoruco group A is 24.8% and group B 16.9%, which is entirely reasonable because the mestizo of the North (Santiago and the Cibao region) have a higher percentage of White blood, while the mestizo of Bahoruco is a mixture of the Indian and the Haitian Negro.

Ciudad Trujillo, on the other hand, shows a high frequency of group O and a scarcity of Rh negative (both of which indicate Indian admixture). The apparent contradiction — Ciudad Trujillo is noted for an absence of the mestizo element — is

due to the fact that the statistics were obtained from examination of members of the National Army, who were probably not all from that city.

The small number of examinations carried out in the Puerto Plata region does not permit any definite conclusions. Those made show definite mestizo characteristics, a high frequency of group O (around 62%), a decrease of group B, and absence of Rh-negative. But on closer observation we notice that the greatest racial influence in Puerto Plata is that of the Negro. The cases examined in that region were members of the National Army, who were most likely not originally from that city. The people of the nearby region of Cabrera have definite mestizo characteristics (due to its isolation throughout the last 4 centuries), as have those of the rural areas of Puerto Plata.

SUMMARY AND CONCLUSIONS

1. The high frequencies of the group O, type M, and type Rh_1Rh_2 in the Dominican population suggest the presence of an Indian component in addition to the original White and Negro components. This Indian component is not uniformly distributed. In the cities, towns and easily accessible rural regions there is little evidence of Indian admixture, while in the mountainous and other isolated regions the Indian influence is pronounced.

2. The Indian component is estimated as 17% for the population as a whole, with, in addition, about 43% Negroid and 40% White ancestry. These proportions vary considerably, depending on the region of the country.

3. Based on the distribution of blood groups in different ethnic types of the Dominican Republic, these types may be classified as follows:

Negro
Mulatto
Mulatto-mestizo
Mestizo
White

The largest groups are the mulatto and the mulatto-mestizo.

4. Finally, answering the question with which I began, the distribution of blood group factors in the ethnic group which I classified *a priori* as mestizo (because of its external physical characteristics) shows that in fact there still exists an Indian mestizo in the Dominican Republic, and that these mestizo elements exist particularly in the mountainous and other less accessible regions of the country.

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SPECIALIZED VS. PRIMITIVE.—I suggest that, from the point of view of anatomy, the Australian and Tasmanian aboriginals should be regarded as examples of one of the most highly specialized of the races of *Homo sapiens*—so specialized that even without the effects of contact with civilization they were probably doomed to extinction in a, geologically speaking, relatively short time. I suggest that it is absurd to continue to regard them as “primitive” in the sense in which that word is commonly used by anatomists. . . .

While there still appears to be a good deal of argument in regard to the real age of prehistoric skulls in Australia, such as those of Talgai, Cohuna and elsewhere, it is usually agreed that they are *not* of very recent age, and belong at least to the Upper Pleistocene.

If *Homo sapiens*, as a species, is not at least as old as the Middle Pleistocene, it becomes difficult to understand how a race of this species could have reached Australia in the Upper Pleistocene times. For clearly this race must have been very well established and have had considerable control of materials to have been able to reach a continent which other Euro-Asian Plio-Pleistocene mammals failed to reach.

. . . it would not be surprising to learn that a true hand-axe culture had been found in Australia or Tasmania in deposits which could be geologically dated to the late Middle Pleistocene.

If and when such a site is found, and if human remains are found with it, the writer, for one, will expect them to be examples of a much less specialized type of *Homo sapiens* than is represented by the present-day aborigines.—L. S. B. Leakey. The age of *Homo sapiens*. *Mankind*, vol. 4, no. 5, September, 1950, pp. 196-200.

AN ANATOMICAL RELATIONSHIP PREDISPOSING TO LUMBOSACRAL FUSION

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ONE FIGURE

Man has developed lumbar curvature as an essential part of fully erect posture. Yet it is not inherited as such, but developed anew in each individual as he learns to walk erect (Bardeen, '05). It seems that the essential spinal adjustment for typical human upright posture is one made during the life of the individual, and that it has not yet become a part of the human genetic heritage.

The functional requirements of erect posture, superimposed on a vertebral column inherited from primate ancestors, demand that skeletal and anatomical adjustments be made during the life of each individual. As the form of the skeleton is closely related to its use or function, it is the purpose of this paper to investigate whether lumbosacral fusion is one such functional adaptation to the mechanical requirements of erect posture. In detail, it will examine the anatomical relationship which apparently is the weakness predisposing to anomalous lumbosacral fusion.

BACKGROUND

Erect posture has been a very early postural adaptation in the evolution of man. The pelvic bones of *Australopithecus prometheus*, together with the details of the limb bones and skull, indicate that this man-ape form walked erect (Dart, '49). In fact, from the evidence at hand, it is a fairly safe assumption that the very earliest fossil men, although transitional from anthropoid to modern man in skull capacity, were

capable of fully erect posture. So, probably, only after the assumption of upright posture did the brain of man increase in size to the point that it certainly exceeded the anthropoid range.

In view of the evolutionary history of man and the importance of erect posture in that history, it is surprising to find that the lumbar curvature, without which man cannot stand erect, has not become an inherited anatomical feature. Possibly one fact that has made the phylogenetic adaptation unnecessary is that the breakdowns associated with lumbar instability come mainly in the later part of the reproductive period, and are rarely lethal. Yet many sections of the body have undergone considerable change with no greater apparent selective pressure. The evidence of erect posture can be found in all parts of the body and many of them are certainly genetically determined in pattern if not in final detail. There seem to be uneven rates of evolutionary adaptation within the anatomical regions of the body with the speed of evolutionary change being unrelated to their apparent functional importance.

Whatever may be the evolutionary position of lumbar curvature, it is a very important anatomical fact. This curve, introduced in a spine inherited from four-legged mammalian ancestors, has caused mechanical strains poorly met by the anatomical structure. No new muscles or ligaments have been acquired by man to meet the new functional requirements resulting from upright posture. However, important changes have occurred in the form of the skeleton, both in the spine and elsewhere. For instance, the reshaping and wedging of the lumbar vertebral segments during life is one such response to physiologic stresses. The development of the external tubercle of the tuber calcanei (Weidenreich, '40) is another such change brought about by erect posture mechanics.

LUMBOSACRAL FUSION

Lumbosacral fusions are an anomalous development in the life span of some individuals and are quite common in adult

populations (Willis, '23; Cushway and Maier, '29; Brailsford, '34; Hodges and Peck, '37; Williams, '37). The frequency is, in general, over 5% as seen in a variety of reported samples, and it increases with the mean age of the subjects. In this report, one sample with a mean age of 24.4 years shows a frequency of 10.9% and another of mean age 61.4 years is 18.3% (see table 1).

These fusions are probably the result of normal bone growth in response to mechanical stress. The increase of any physiologic stress in the limits of tolerance acts as a growth stimulus on bone (Weinmann and Sicher, '47). In particular, fusing of the last lumbar segment to the sacrum or ilium is the culmination of a process of extensive marginal lipping, with the lines of extension probably following the ligaments. Whatever may be the detailed process of the formation of the bone, the result is to increase the security of the area. Murray ('36) has the following to say about the process of bone changes: "... There is no doubt that adult, fully formed bone, subjected to a changed pattern of mechanical stressing, can meet the new demands made upon it with a changed structure, and that the new morphological pattern so produced is, in respect of the new mode of stressing, more efficient than the old." (p. 134).

Inherited normal variation in skeletal structure gives some persons a superior pre-adaptation to the subsequent demands of erect posture. This is the condition of the majority of individuals in respect to the development of lumbosacral fusion. It is only a minority who inherit the mechanical relationship which predisposes them to eventual complete fusion. A greater number, by far, are involved with extensive marginal lipping which is the same response, to a lesser degree, to the stressing of erect posture. In fact, the general positive relationship of skeletal anomalies to excessive physiologic stress seems to explain the frequency and variety of most anomalies which concentrate in the lumbar region (Willis, '23). The development of many of these anomalies overlies the inherited variations and is apparently correlated inversely with the struc-

tural or mechanical efficiency of the inherited structure. The fact that some persons develop lumbosacral fusions is evidence that they inherited structures inadequately stressed to the mechanical forces involved.

MATERIALS AND METHODS

In the course of a recent investigation the author (Thieme, '50) examined the mechanics of the lower lumbar region to discover whether some human disorders, including herniated intervertebral discs and spondylolisthesis, are associated with the evolutionary assumption of erect posture. As one part of this study, the mechanics of the lumbosacral region were examined to see if some deviant structural relationship could be considered the underlying cause of spondylolysis. This later aspect of the research, in contrast to the main investigation, proved negative. However, another outcome was the finding of a mechanical relationship highly correlated with lumbosacral fusion. This aspect of the original investigation has supplied the material for this report.

The author examined roentgenographic films of 55 adult male medical students ¹ (hereafter called "Students") without a history of low back pain, posed in relaxed erect posture in a standard position at a fixed distance from the ray source. In addition, 82 known male skeletons ² (with 66 of these of known race and age), prepared from dissecting room cadavers but of unknown medical history, were also examined and measured. In the films of the medical students, mathematical corrections were made to compensate for distortion and make both sample measurements comparable. However, as the skeletal material and the students are not compared in the analysis

¹ The films of the medical students were made available to the author through the courtesy of Dr. Robert P. Ball, Department of Roentgenology, Presbyterian Hospital, New York City. By making these films available, together with viewing facilities and much helpful advice, Dr. Ball made this compilation possible.

² A portion of the collection of The Viking Fund and American Museum of Natural History sponsored Institute of Human Morphology.

which follows, it is not essential that the x-ray and skeletal measurements be exactly comparable.

In the material that follows, the comparisons are made within the two quite different yet individually homogeneous samples. In each of the two sample populations the fusion cases are compared with the non-fusion cases to test the assumption that significant differences in important mechanical structures may be the causes of the fusion or non-fusion response.

The lumbosacral region, as a weight-bearing skeletal structure, was measured in relation to its mechanical functions. Weight forces passing down the spine are borne through the vertebral bodies and intervertebral discs and passed to the sacrum. They are then transmitted through the sacro-iliac arch to the acetabula, and thence down through the legs and feet. Between the superior sacral surface and the acetabulum, the pelvic brim, as marked by the iliopectineal or arcuate line, is the superior edge of the bony thickening which is important in supporting this weight.

By considering only the weight which is transmitted to the pelvis through the vertebrae, the mechanical problem is simplified. In *norma lateralis* the only pelvic structures relevant to weight support are the sacral superior surface, the thick bone between the sciatic notch, the superior brim of the true pelvis, and the acetabula. The pubic arch is vital in holding the pelvis in stability but is not directly involved in the transmission of weight forces.

In this problem only landmarks which are functionally related to mechanical weight bearing are included. Also, those marks were utilized which are clear on radiographic films and comparable to skeletal landmarks. The points and measurements, all from *norma lateralis* on the films, were taken as follows ³ (see fig. 1):

³ Figure indicates the points and measures used in this investigation but does not show the considerable number which were taken in the original investigations and not pertinent here.

Point A. The point at the intersection of the projected iliopectineal line and the anterior surface, or its projection, of the sacrum.⁴ (This point may lie superior to the sacrum and to the left of the sacral promontory in the diagram. In such cases the measurement [no. 1] is considered as negative.)

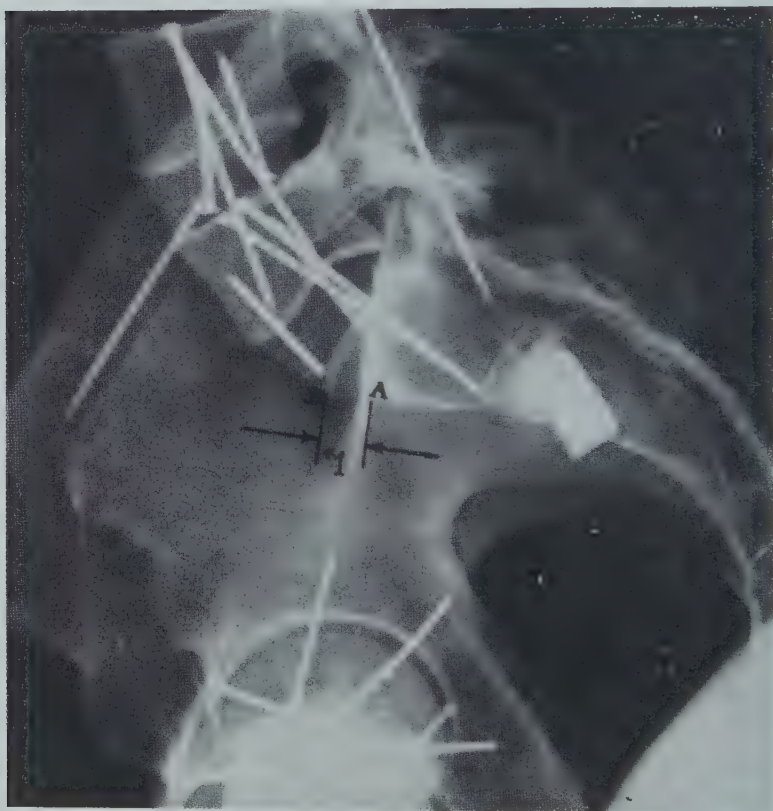


Figure 1

Point B. The sacral promontory.

Measurement no. 1. The distance from Point A to Point B (in millimeters).

⁴In the film this point is usually clear and corresponds to the top of the "saddle" which is lateral to the superior surface of the sacrum and is the continuation of the brim of the true pelvis. X-ray films make the use of this important weight bearing landmark possible on the living. Although it is not an easily defined landmark on skeletal material, it can be quite accurately found if the orientation of the pelvis in the x-ray film is kept in mind.

RESULTS

The difference between the fusion and non-fusion cases in each sample is quite significant. Using the statistical test for difference, the values of the variance ratios, given as "t," are well beyond the 1% levels of probability and indicate the very strong likelihood that the differences are significant and not due to chance. The difference between the means of the "fused" compared to the "non-fused" in the "Students" is over 21 mm. It is of considerable interest that the ranges of the two "Student" groups overlap in only one case (5 mm) so that, in this total sample, it would be possible to tell which were fusion cases merely by measuring the norma lateralis film, except in the one case.

It is strongly recommended because of the small size of the sample studied that other investigations be made to see if the results are as clear as they appear here. Yet at the same time it may be stated that the tests for significance take into account the small numbers of the sample. The results therefore are highly significant and certainly indicate that the differences found are not due to chance.

It would seem from these findings that if an individual has developed a sacrum which is recessed downward in relation to the true pelvis, resulting in a sacral promontory which does not project above the intersection of the arcuate line and the anterior sacrum, that he will probably develop a lumbo-sacral fusion. In fact, a projection of 5 mm or less in this measure (no. 1 in the diagram) is a strong indication that normal fusion will occur during the life of the individual.

The average age for the "Students" is 24.4 years, and for the skeletal series, where the age is known, is 61.4 years. This very marked age difference between the two samples probably accounts for the difference in the frequency of fusions, and also for the fact that the range of the measurements between the "fused" and the "non-fused" overlap more in the older sample.

TABLE 1

Distance from the sacral promontory to the intersection of the arcuate line and the sacrum. (Distance no. 1 between points A and B)

SERIES-SAMPLE	MEAN AND STANDARD ERROR ¹	STANDARD DEVIATION AND ERROR	NUMBER	RANGE	% FREQUENCY OF FUSION	VARIANCE RATIO OF FUSED TO NON-FUSED ²
"Students"					10.9%	11.7
Without fusion	19.96 ± .34	2.38 ± .24	49	5 to 39		
With fusion	— 1.17 ± 1.77	4.34 ± 1.26	6	— 7 to + 6		
Difference	21.13 mm					
Museum skeletons					18.3%	5.5
Without fusion	17.66 ± .51	4.15 ± .36	67	8 to 28		
With fusion	5.07 ± 2.24	8.69 ± 1.59	15	— 20 to + 19		
Difference	12.59 mm					

¹ The standard error added and subtracted from the mean and standard deviation gives an indication of the range within which two-thirds of the statistics of similarly sized random samples could be expected to fall when derived from the same parent population.

² The "variance ratio," a measure of the significance of difference, is computed by dividing the difference between the means being tested by the square root of the sum of the squares of the standard errors of the means. If the ratio is 2, the odds are approximately one in 20 that the difference is due to chance. Greater ratios make the possibility that there is a significant difference between the means more likely.

DISCUSSION

Point "A", the intersection of the line of the anterior sacrum and the arcuate line, in this analysis is a functional point related to the mechanical problem at hand and was not arbitrarily chosen because of ease of measurement or traditional anthropometry. As the findings suggest, persons who have the

point of intersection close to, or anterior to, the sacral promontory are predisposed to normal lumbosacral fusion.

A mechanical analysis indicates why this relationship exists. If the point of division of the forces that are transmitted down the spine and out to the right and left legs is anterior to the sacral promontory, the sacrum does not fully participate in the transmission of forces. The sacrum, then being out of the direct line of force, or partly so, does not perform its mechanical function normally. New bone, in effect a new superior sacral element build up in response to abnormal strain, bridges the last lumbar vertebra to the sacrum and/or ilium to give the security that the ligaments and connective tissue fail to give.

On mechanical grounds, it may be valid to say that the first sacral segment is the last segment in the spinal column which is directly involved with the division and transmission of compression forces from the spine to the legs. Also, the first sacral segment is the one with any part anterior to the intersection of the arcuate line and the anterior sacral surfaces. In other words, point "B" must be anterior to point "A" if it is truly the sacral promontory. If this relationship is not found in the individual, due to inherited skeletal variation, supporting fusion bone will be built up during his life span to give lumbosacral security. This process is clearly brought about by the mechanical requirements resulting from lumbar curvature and erect posture.

These findings indicate that the anomaly known as fusion of the lumbosacral joint can be added to the list of anatomical and skeletal changes during life resulting from the assumption of erect posture by man.

ACKNOWLEDGEMENTS

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EARLY STAGES IN HUMAN EVOLUTION.—With a brain well within the human range it seems impossible to deny human status to the Swartkrans ape-man, and as he is clearly allied to the smaller-brained *Australopithecus* we seem to have at least two well-marked stages in the evolution of man.

In the next 5 or 10 years we ought to have many more stages, and to know fully the steps by which man evolved from a primate with a brain of 500 cm³ to one with over 1,000 cm³.—R. Broom and J. T. Robinson. One of the earliest types of man. *South Afr. J. Sci.*, vol. 47, no. 2, 1950, pp. 55–57.

FACTORS OF HUMAN PHYSIQUE

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FOUR FIGURES

THE ANTHROPOMETRIC TECHNIQUE

Anthropometric measurements are the central technique of physical anthropology. They were developed, in the course of a relatively long and honorable history, as a descriptive method, as a special refinement of the whole taxonomic approach. They were first applied, of course, to racial distinctions, and later to other studies of differentiation of groups, e.g. by environmental effects, criminality, growth; as well as to primatology, to military anthropology, and so forth.

Basically, as it is presently used, the technique leads simply to a more and more exact definition of an individual, or of the type of a group, so that a sculptor might thereby reconstruct a skull, or a type, and the more perfectly so the more thoroughly and carefully it had been measured. The measurements used remain distinct items. This is only one step, scientifically. Of course, the measurements (or the type constructed) are also used, with the aid of statistics based on sampling theory, as a method of discriminating between groups, as to whether they differ "significantly" in hereditary (e.g. racial) or environmentally modified (e.g. generation dif-

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ferences) qualities. This is important; but we have no good criterion as to how many differences we should take into account, or which of them are of prime importance. Put another way, we have no criterion but guesswork for assessing what is represented by the measurements: no way of telling which ones register basic parameters, or axes of growth (or what measurements might be found which did register these things), and which ones are simply repetitions of others, or else are complex and on the whole meaningless resultants of others.

This means that researchers simply make choices from the standard list of measurements, and then go in search of a set of differences between two groups. The guides to the choice of measurements made are tradition and common sense, and the differences found are assessed (following a rather senseless anti-discrimination policy) on an equal basis and separately for each measurement in the list, whatever summing up may be done. This leads to a final conclusion, that the groups involved do or do not differ significantly, but the whole process leaves little leeway for making scientifically controlled estimates as to which diameters, or measurable features, are really close and significant representations of hereditary, hormonal, or other forces of individuation.

This is not meant to disparage the kind of study described, in any way. It is only meant to indicate that the present stage of development, which has persisted for some time, has limitations for advanced research into the causes of differentiation. Possibly these limitations are exaggerated here, because of the writer's own concern with them (Howells, '43; '48). But they exist, and they have caused some merry comment, among the genetically-minded in particular who, observing that the cephalic index has resisted mendelian analysis, suggest that the whole business of measuring be abandoned while there is still room on the front benches of blood-typing. This attitude seems to imply that the human form, external or skeletal, has lost its significance with the rediscovery of Mendel's laws, and that measurement, as a

descriptive and taxonomic device, no longer has point. This is not so. The cephalic index, introduced in 1842 by Retzius, would have been a joke by 1843 if it did not obviously represent something real in the variable development of the human skull — just what has not been determined, but if it were not something of genetic significance it would never have been used with any profit at all in racial descriptions.

Another escape route from separate, atomizing measurements and from group types, or averages, was offered by Sheldon. Taking the bull by the horns, he gave recognition to three basic factors controlling any physique. This involves a very considerable shift in ideas, and an appealing one, in the introduction of the notion of components. The system results in types, of course, but these are seen as the graded combination of more basic factors, and not as exclusive subgroupings of a population, the rather arid conception of types which prevailed so long. Measurements, similarly, become the regional expressions of the combined components, as far as they mean anything, instead of having to stand in isolation. However, this system is certainly not the logical extension of development of the anthropometric technique. Neither system has been explained or interpreted in terms of the other; the somatotype components are subjectively determined and have not been validated or explained on an experimental basis, and the system has the same limitations as recent anthropometry: it sets down new findings in its own terms without shedding light on the nature of the terms themselves.

In the general situation, one thing needed is a further development of statistics, to go beyond tests of differences of measurements where the meaningfulness of the measurements has already been taken for granted, and instead to examine the measurements themselves and their interrelationships; and in that way to attempt to determine *which* differences will be biologically significant if they turn out to be statistically significant. In brief, we have covered the human physique and skeleton with a skein of external measurements but

we have not found where this skein of external description makes useful contact with the underlying system of factors controlling development and differentiation. We have not bridged the distance between appraising body form by measurement and comprehending the organizing factors which the body form expresses. We have measured the general breadth of the head and face region at numerous points: biasterionic, maximum, biporion, bistephanic, frontal, biorbital, bizygomatic, bigonial, etc. But we do not know what the basic factor for breadth is, whether there is more than one, or how many. We have analyzed nothing of the sort and yet such an understanding, could we arrive at it, might open up possibilities of studying much more precisely the behavior of the body form in heredity, or under environmental changes.

This cannot be done, in the immediate future, by genetics, though in the end these studies must overlap. It must be done, therefore, by practical analytical methods, both experimental and statistical. It is probable that steps may be taken in this direction by the use of factor analysis. The probability has been urged before, especially by Tanner ('47), and will be discussed in this paper. Developed by psychologists largely in connection with the analysis of mental tests, factor analysis has now reached the point of providing a choice of useful and simplified methods. It is apparently so well adapted to physical measurements that workers have more than once used such measurements as material for discussion of methods, and Burt regularly uses them in training students (Burt, '47; Burt and Banks, '47; Thurstone, '46b). It has not yet, however, been applied by anthropologists, and its possibilities have not been made definite. In any case, it is intended for use on material for which experimental control is difficult, and in which the basic factors can be measured only indirectly (see Burt, in Tanner, '47). It is thus particularly useful for human material, including social phenomena; there is little point in its use with general biological data, or those of the physical sciences, where full experimental control is possible.

FACTOR ANALYSIS

Nature. Factor analysis is a body of statistical techniques for simplifying the relationships of various measures or tests, and thus for clarifying what it is that these are basically measuring or testing. It does so by taking all the correlations between the measures and attempting to explain the whole by means of several underlying factors which are fewer in number than the measures used. Just as a mean is a device for making simpler the comprehension of unorganized individual measurements, and a coefficient of correlation a more complex device for making organization still broader but also simpler and easier of interpretation, so factor analysis is a still more complex device to make interpretation still broader but still simpler (for general statements, see Thomson, '50; Burt, '47; Holzinger and Harman, '41, ch. 1; and Thurstone, '47a).² The factors so extracted are abstractions, but they may ideally measure realities which are more important than the original measurements themselves (see Tanner, '47).

Take the following imagined small table of r 's:

	.9 Stature	.8 Sitting ht.	.5 Head l.	.6 Face ht.
.9 Stature	x	.72	.45	.54
.8 Sitting ht.	.72	x	.40	.48
.5 Head l.	.45	.40	x	.30
.6 Face ht.	.54	.48	.30	x

The degrees of correlation vary: stature is more highly correlated with sitting height than with head length. But in-

² "Factor analysis is a branch of statistical theory concerned with the resolution of a set of descriptive variables in terms of a small number of categories or factors. This resolution is accomplished by the analysis of the intercorrelations of the variables. A satisfactory solution will yield factors which convey all the essential information of the original set of variables. The chief aim is thus to attain scientific parsimony or economy of description" (Holzinger and Harman, '41). "Factor analysis may be described as a statistical technique for reducing a *large* number of *correlated* variables to a *small* number of *uncorrelated* variables" (Burt, '47. The "*uncorrelated*" is unnecessary and in fact undesirable; see Thurstone, '47b, p. 139).

spection of the table shows that the rows or columns are proportional, and so there is actually no special arrangement of these measurements, and it is only a question of the *intensity* of the correlation of the several measurements. This puts the idea in a different way: a larger proportion of the *variability* of stature is involved in these relationships than of the variability of head length, etc., but this is all that accounts for the differences in the r 's. Accordingly, the whole table can be explained by one factor, with which the measurements are individually correlated as follows:

Stature	.90
Sitting height	.80
Head length	.50
Face height	.60

These values have been put at the rows and columns of the table, and it is to be seen that cross-multiplying them at the proper boxes will reproduce all the coefficients in the matrix. Hence the same common factor accounts for all these relationships, but is expressed more intensely in stature than in others (stature has the largest "loading" (U.S.) or "saturation" (British). If this were an actual case, it would obviously be proper to interpret this factor as one of "size." Simple body size, then, would explain a high proportion of the variation existing in stature, and a lesser proportion of the variation existing in head length, but in any case, nothing *but* size would be necessary to explain the *correlated* variation of this set of measurements.

One general method of determining that a single factor is responsible for all the covariation of a group of measurements follows from the above. When such a factor has been computed from an actual matrix, it is then used to reproduce a matrix such as *would* exist if this *were* the only factor necessary to explain it (by cross-multiplying the factor loadings), and then to subtract this reproduced matrix from the original one. This should leave nothing but negligible and random residuals. This of course is the case with the example

used above, where nothing but zeros would remain. It would not be the case with the very similar example below:

	STATURE	SITTING HEIGHT	HEAD L.	FACE HEIGHT
Stature	x	.72	.45	.54
Sitting ht.	.72	x	.40	.48
Head length	.45	.40	x	.60
Face ht.	.54	.48	.60	x

Here, if the factor used in the first instance were subtracted from the matrix, a considerable residue of correlation would remain between head length and face height. This would require explanation by a second factor. Thus there would be two factors, a general one, again supposedly size, and a factor common only to head length and face height, which could be interpreted as sagittal cephalic growth. (These data are all imaginary, and should be forgotten at this point.)

Procedure. The number of factors present in a given series of measurements is determinate (equalling the rank of the matrix of correlations), but there is a variety of ways of extracting them; how this is done depends on the kind of interpretation wanted. A typical process, particularly suitable for anthropometric material, consists of the following steps: from a table of correlation coefficients, a series of factors (each uncorrelated with the others) is extracted, and the contribution of each is subtracted from the matrix in succession before the computation of the next; until no significant degree of correlation remains in the matrix; these uncorrelated (orthogonal) factors are then rotated (in the geometrical sense) into oblique, non-orthogonal positions until they afford the sharpest and most easily interpreted relations and distinctions among the original measurements, and at the same time express the correlation basically existing between the factors themselves (since the oblique factor axes are now correlated).

This process can be illustrated by a specific example, set forth in figure 1. The material is a matrix of 8 measurements on a Welsh sample, measured by Fleure and taken

from Hammond ('42);³ this is shown in table 1. This being a problem with three factors, it is possible to represent it (fig. 1) as if it existed in actual space. To begin with, the correlations themselves establish the relationships of the measurements in space, as they are shown in figure 1, without reference to factors, or anything else in the diagram. What actually happens is that the factors are fitted to the existing vectors of the correlated measurements, not vice versa.

The factors are extracted by the centroid method (see Thomson, '50, p. 23; or Thurstone, '47b, ch. VIII). The first

TABLE 1
Correlations, Hammond's data, and third factor residuals

	1	2	3	4	5	6	7	8
1. Head circumference	...	.053	.006	— .019	.053	— .057	— .017	— .041
2. Head length	.844	...	.003	— .018	— .008	.004	.022	— .017
3. Head breadth	.521	.385	...	.020	.021	— .030	— .010	— .019
4. Face height	.471	.465	.192	...	— .070	.049	— .004	.056
5. Face breadth	.567	.434	.668	.289	...	.026	.011	.017
6. Arm breadth	.339	.210	.238	.065	.449	...	.000	.003
7. Leg breadth	.187	.178	.202	.078	.323	.616	...	.015
8. Stature	.221	.196	.248	.172	.362	.652	.707	...

factor values are obtained by dividing the sums of each complete column (after inserting estimated diagonal values) by the square root of the sum of the whole matrix, essentially getting the correlation of each variable with all the variables. This finds a "center of gravity" of all the measurements, and erects the first centroid (F_1 in fig. 1), or orthogonal, factor in a position representing this general center of the measurement vectors; its numerical values are the readings of the various measurements vectors projected against it at right angles.

³ Hammond extracted two factors, but a third is suggested by the material, and recalculation by the author gives three factors with the highly satisfactory solution here presented.

Subtraction of this factor, the total average correlation, leaves the total value of the residual matrix at zero, a sum of positive and negative values. Changing signs of suitable columns and rows (reflecting the measurement vectors at the origin — see Thurstone, '47b) increases the positive value to the maximum, and the next factor is extracted. This (F_{II}) is at right angles to the first; i.e. necessarily uncorrelated with

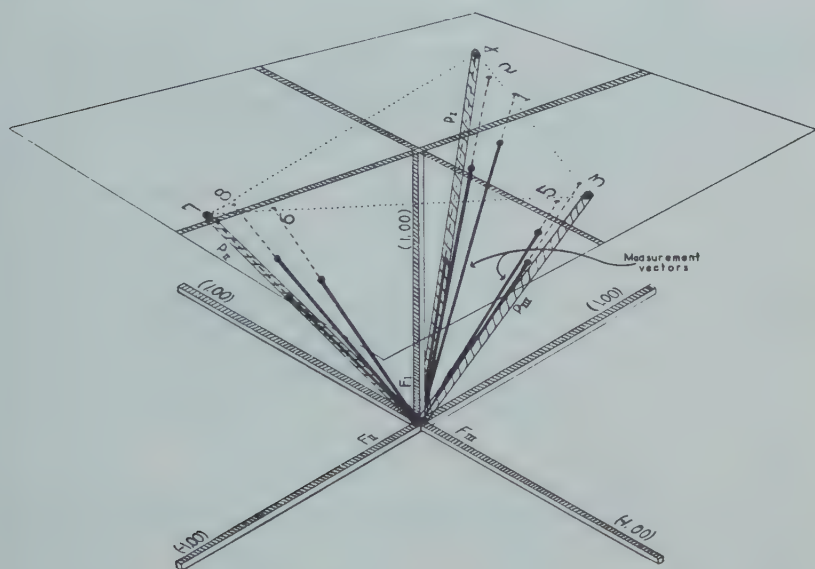


Fig. 1 Relationship between measurement vectors, orthogonal factor axes (F_I , etc.), and oblique factor (primary) axes (P_I , etc.). Measurement vectors are also shown extended to the plane of $F_I = 1.00$, giving plot shown in figure 2. Hammond's data.

it. Repetition, and extraction of a third factor, leaves only small residuals. The third factor (F_{III}) is again at right angles to the others; that is, they are orthogonal and have zero readings on one another. The three centroid factors are shown in the matrix, F , in table 2.

We now have a complete explanation of the relationships of the measurements in terms of three factors. It is possible now to get a simple representation of the measurements

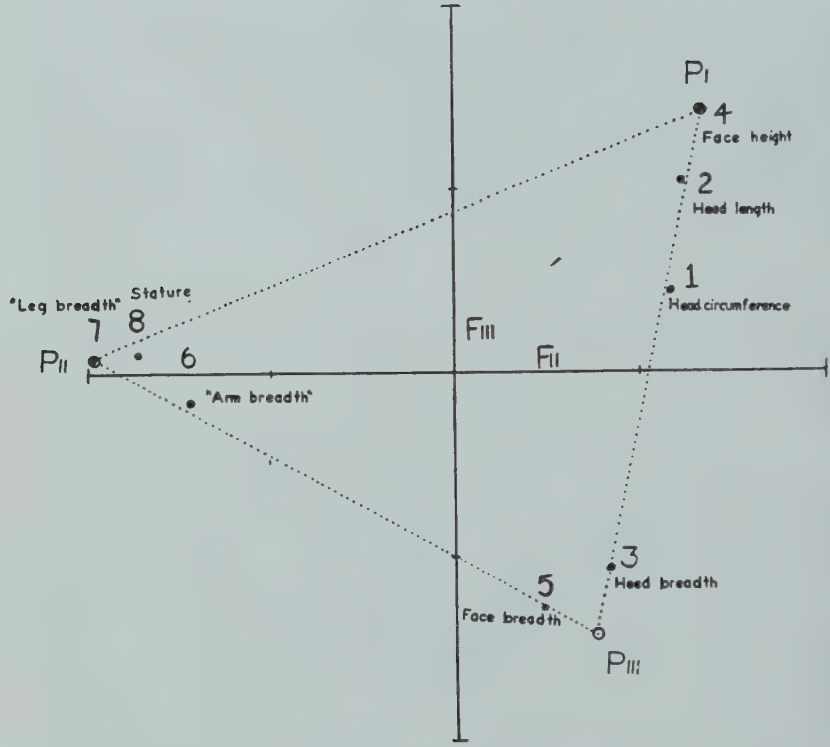


Fig. 2 Extended vector plot, Hammond's data.

TABLE 2
Hammond's data

	CENTROID FACTOR MATRIX, F			EXTENDED VECTOR VALUES		
	F_I	F_{II}	F_{III}	I	II	III
1. Head circumference	.798	.461	.165	1.00	.58	.21
2. Head length	.676	.421	.353	1.00	.62	.52
3. Head breadth	.582	.245	-.306	1.00	.42	-.53
4. Face height	.400	.269	.284	1.00	.67	.71
5. Face breadth	.773	.185	-.496	1.00	.24	-.64
6. Arm breadth	.624	-.452	-.051	1.00	-.72	-.08
7. Leg breadth	.577	-.568	.015	1.00	-.98	.03
8. Stature	.646	-.561	.033	1.00	-.87	.05

themselves by using these factors as axes. This produces figure 2, which already appears in figure 1. Imagine a plane set parallel to that formed by F_{II} and F_{III} in figure 1, passing through F_I (necessarily at right angles) at the point $+1.00$ on the latter; extend the vectors of the measurements in their proper directions until they hit this plane (Thurstone, '47b, ch. XI), and figure 2 is given: F_{II} is the horizontal axis, F_{III} is the vertical axis, and F_I is vertical to the page at the origin point. This is done simply by making the F_I values equal to 1.00 for all measurements, and the values for F_{II} and F_{III} proportional by simple division (this in effect makes triangles proportional to those formed by the original vectors and their projections on F_I , but with these projection lines now all in a single plane), and plotting the last two factors on a graph.

The extended vectors, as plotted in figure 2, form a clear triangle, revealing the presence of three factors, and suggesting that these factors could most clearly be represented by *oblique* axes passing through the origin and the corners of the triangle (P_I, P_{II} and P_{III} in figure 1). These can be derived from the orthogonal factors by a method of Harris ('48). This is efficient and labor saving, particularly when used for a larger number of factors; it cannot be detailed here, but is simply described in Harris' paper; the steps are followed in table 3. The extended vector readings of the measurements at the corners of the triangle, or of the corners of the triangle itself, are turned into direction cosines to give a transformation matrix, T . If the orthogonal matrix, F , is postmultiplied by T , a structure matrix, S , is obtained, which gives the correlation of each measurement with the new *oblique axes*, or the reading of its projection at right angles on these axes. Another matrix, $T'T = \Phi$ (T transposed and postmultiplied by T itself), gives the correlations of the *oblique factors* among themselves. Finally, the multiplication $S\Phi^{-1}$ gives P , the pattern matrix, or the *coordinates* of the measurements with the new primary axes, or oblique factors, which in figure 1 pass up through the

corners of the triangle. (With the original orthogonal factors, structure and pattern are the same, and the correlation of the factors is zero.)

These matrices, particularly the pattern, are the final expression of the factors in this case. The pattern is the best measure of each measurement in each factor; it speaks for

TABLE 3
Hammond's data

DIRECTION COSINES, T				CORRELATIONS OF PRIMARIES: T'T = ϕ				
	(4)	(7)	(5-3)		I	II	III	
I	.716	.714	.812	I	1.000	.187	.478	
II	.479	— .700	.309	II	.187	1.000	.353	
III	.508	.021	— .495	III	.478	.353	1.000	
Inverse, ϕ^{-1}								
		I		II		III		
	I	1.296		— .027		— .610		
	II	— .027		1.144		— .391		
	III	.610		— .391		1.430		
OBLIQUE FACTORS								
	Structure matrix FT = S			Primary axis pattern matrix $S\phi^{-1} = P$			Simple axis pattern matrix PD = V	
	I	II	III	P _I	P _{II}	P _{III}	V _I	V _{II} V _{III}
1. Head circumference	.876	.251	.709	.70	— .01	.38	.61	— .01 .32
2. Head length	.865	.195	.504	.81	.00	.12	.71	.00 .10
3. Head breadth	.379	.238	.700	.06	— .01	.68	.05	— .01 .57
4. Face height	.560	.103	.267	.56	.00	.00	.49	.00 .00
5. Face breadth	.391	.412	.930	.07	.10	.93	.06	.09 .78
6. Arm breadth	.204	.823	.392	.00	.78	.11	.00	.73 .10
7. Leg breadth	.149	.810	.286	.00	.81	.00	.00	.76 .00
8. Stature	.211	.855	.335	.05	.84	.02	.04	.79 .01

itself; it is clearly defined and easy of interpretation, and it confirms the indications of relationships seen in figure 2. This pattern is of course not *the* solution, or unique, it is just the most expressive, for most purposes.

The last matrix in table 3 is the simple-axis solution preferred by Thurstone; it is derived from the pattern matrix

P by multiplying the columns by the reciprocal of the square root of the corresponding diagonal values of Φ^{-1} . This has some advantages; it expresses the factor loadings as the correlations of the measurements with the simple-axes of Thurstone, reducing all the columns to the same scale; this last does not hold for the P values.

Interpretations. This matrix is chosen for illustration, and the actual factors in it are not particularly informative, and probably somewhat misleading, because of the measurements involved. Those of the body are isolated from those of the head under one factor, P_{II} , and the head measurements present two factors, one (P_I) associated with sagittal diameters, the other (P_{III}) with breadths; head circumference, as should certainly be expected, is a function of both of these last two. All these relationships are visible in figure 2 as well. The analysis demonstrates a clear solution very well, because of the few factors and measurements, but for the same reason, finer actual distinctions do not appear: body measurements appear here as one factor, and head length and face height come together under another, both results which are contradicted by fuller sets of measurements. Three variables are necessary to define a factor, and in this case it is obvious that potentially distinct, correlated factors collapse into single factors because of the paucity of measurements. Further, the point is illustrated that factors in these analyses are not absolutes, but are abstractions from a particular body of data, and specific for it. Generalizations cannot be built on any one set.

Figure 1, then, demonstrates quite simply the relationship of measurement vectors, orthogonal factors and oblique factors. It can be used to clarify understanding of certain other points, such as different treatment by different schools of analysts, leading to different interpretations. In the first place, English workers, following Burt, prefer resting on an orthogonal solution, i.e. the centroid factors. These have the general pattern of the centroid matrix given above (table 2), with a first "general" factor, with sizeable positive load-

ings, a second "bipolar" factor, with a clear division into positive and negative loadings, followed by other bipolar factors redividing the groupings indicated by the second. Actually, it can be seen, this pattern of interpretation is dictated by the centroid method, in which the second factor necessarily balances the variables in positive and negative values, and it is possible that the notion of "bipolarity" in factors of physical form thereby gets too much emphasis. In any case, with a considerable number of factors interpretation of orthogonal factor values is difficult. American workers generally now prefer to proceed to some sort of an oblique solution in which (in physical measurements) general and bipolar factors do not appear. Figure 1 shows, however, that both groups are talking about the same thing in different ways. The variables, as has been said, are set in space by their correlations. The English, principally Burt, prefer to describe them and understand them in terms of the orthogonal factors, of which the first, F_1 , sticks up through the middle of the measurement vectors, and determines that the others must be at right angles to it; the Americans prefer to describe them in terms of the oblique P factors, which are not at right angles, and which severally stick up through related *groups* of variables, having been placed there as the best attempt to locate the distinct and independent, though possibly correlated, underlying factors which are registered by the variables. The two systems come together in figure 2, which is the triangle on the projected plane in figure 1.

There has been some argument as to the existence of a general factor in physical measurements, as against group factors only, and Burt in particular ('47; Burt and Banks, '47) has been at pains to affirm the existence of a general factor against some earlier denials by Spearman and a general interest in group factors by others. The answer seems to appear in figure 1 readily enough: there is indeed a general factor in this case, which is apparent from the fact that the correlation matrix is positive throughout to begin with; and

accordingly all the measurement vectors lie on the same side of a single plane (that normal to F_I). When orthogonal factors are taken, the general factor is expressed in F_I , the first centroid, with all positive loadings. When oblique factors are used (P_I, P_{II}, P_{III}), none of them appears as a general factor, because none is meant to; these are intended instead to highlight certain groups of measurements as registering group factors, with all the attendant advantages in being able to describe the measurements by groups, and as being expressions of a single factor, or of two, or of three, etc. The general factor appears, instead, in the matrix Φ , of the positive (in this instance) intercorrelations of the oblique factors, and graphically in the fact that the oblique factor axes, like the measurements, all lie on the same side of the base plane of F_I , and form acute angles with one another. The general factor is there, in F_I , any time it is wanted. Otherwise it is entirely a question, not of what is being expressed, but of how to express it. (See also Thurstone, '47b, ch. XVIII, also p. 192).

PREVIOUS APPLICATIONS

About two dozen studies of physique by methods of factor analysis have been made, most of them being noted and briefly abstracted in a doctoral dissertation by Heath ('50). Almost without exception these have employed data originally gathered for some other purpose and consisting of varying sets of the usual measurements of the head and body, particularly the latter. That is to say, no report has been published of a deliberate attempt to seek out factors of a given type, or for a specific region, and results have been on the whole somewhat indefinite for this reason. Other consequences which also follow from the same reason have already been mentioned. In the first place, factors distinguished are necessarily those for a given population and a given set of measures, and hence there could hardly be any high degree of comparability in the findings of the sort of afterthought study described. Secondly, and connected with this, is the fact that three measurements will not determine more

than one common factor (see preceding section), so that in Hammond's data the three body measurements all collapse into a single factor, and in other studies there may appear a single "head" factor, for the same cause; the effects of this kind of accidental selection of measurements used, on the comparability of factors found, can be imagined.

Analyses reported from 1938 to 1945 rested almost entirely on centroid solutions and produced, typically, a restricted number of factors in any case, usually two or three. These tended to be a "general growth" factor together with a "limb" and a "thickness" factor, or else a general factor and a bipolar factor opposing linearity and body fullness; occasional extra factors were associated with fat, or with the head, or unidentified. More recently there have been a few studies using fairly large sets of measurements and a more exhaustive factoring, yielding 5 to 7 factors (in some cases evidently too many), and making rotations to oblique solutions; with so many factors, simple centroid solutions become very difficult to interpret. It might be said that the work has only just arrived at the suggestive stage, where further exploration might profitably be made to clarify the nature of what has been indicated so far.

In general, the following seem to be the principal findings to date: (1) The data do not insistently point to any factor of general size, other than a correlation between principal body factors. Stature is distinctly the resultant of two independent factors. (2) A distinction constantly appears between limbs and trunk (and head, where this is represented by measurements), with linearity strongly associated with the limbs. (3) Distinctions appear, still vaguely, within the trunk (e.g. Thurstone, '47a); there are indications of factors for chest development vs. general body fullness vs. fat. This in particular would seem to be a field for immediate study, since techniques of measurements of the trunk do not seem to be yielding all the information to be had.

Two interesting recent studies are those of Moore and Hsu ('46) and Heath ('50). The former, using 31 measurements

of both head and body, yielded 7 factors, some of which seem to agree with those described hereafter in this paper; the authors were unable to interpret all their factors, however, and it is evident that some of them need further rotation before they will make sense.

Miss Heath used 29 measurements of the body taken in a study for women's clothing size standards, and got 5 factors. Two of these were bone length and "cancellous bone size;" she ventured this latter designation from the association of this factor with joint circumferences, sitting height, and limb girths, suggesting that it might be related to a vertebral contribution to the "trunk size" identified by other workers. Her other three factors, all circumferential in character, were circumference of extremities, girth of upper body, and girth of lower body; these last two factors certainly suggest a promising distinction, and waist girth was found to have loadings on both of them. Miss Heath also extracted second order factors (i.e. factored the factors—see the fourth section following, and Thurstone, '47b, ch. XVIII), with the result that the 5 factors originally found were neatly divided into two groups (as above), which she denoted as associated with bone size on the one hand and with fat on the other. No general factor was suggested by either the first or the second order factors.

MATERIAL AND ANALYSIS

The subjects studied here are 152 students of the University of Wisconsin. They happen to be paired brothers: this material has been used before (Howells, '48, '49). Like practically all the data worked in previous analyses, these were not collected with factor analysis in mind. Like almost none of the previous sets of measurements, this one includes a preponderance of head measures, and very few on the trunk. The significance of these points has already been pointed out.

In table 4 there are presented the intercorrelations of the measurements of this sample and, in the northeast half of the

TABLE 4

Correlation matrix, R (and 7th centroid factor residuals)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Stature	...	+.042	+.002	-.031	+.023	+.027	+.001	-.009	+.003	+.013	-.002	-.063	+.005	+.032	+.016	+.031	-.019	-.031	-.042	-.015
2. Sitting height	.752	...	+.023	-.034	-.045	-.037	+.024	+.015	+.071	-.102	-.021	+.026	+.088	+.025	+.018	-.057	-.006	-.013	-.011	-.025
3. Upper arm length	.707	.385	...	+.026	-.024	-.044	+.016	+.020	-.058	.000	+.017	+.031	-.036	-.027	-.001	+.003	+.001	+.063	-.015	-.014
4. Lower arm length	.745	.376	.735	...	-.005	+.012	+.007	-.057	-.085	+.026	-.001	+.047	+.015	+.010	-.020	-.025	-.004	+.026	+.061	+.017
5. Lower leg length	.823	.363	.724	.816	...	-.007	-.005	+.047	+.143	-.043	+.002	+.008	+.010	-.018	+.005	-.013	+.004	-.080	-.010	-.005
6. Biacromial breadth	.458	.417	.272	.350	.341	...	-.068	+.003	+.031	+.057	-.010	-.020	-.047	-.027	+.015	+.036	+.025	+.010	+.017	+.009
7. Bi-iliac breadth	.519	.325	.438	.449	.465	.338	...	-.018	-.018	-.011	+.019	+.057	-.021	-.012	+.032	-.022	-.006	-.011	-.003	+.008
8. Head circumference	.251	.285	.189	.259	.136	.318	.220	...	-.036	+.026	+.003	-.013	-.001	+.019	-.010	-.004	+.021	+.027	-.003	-.017
9. Head length	.268	.275	.200	.231	.488	.294	.115	.792	...	+.067	-.001	-.055	-.081	-.003	+.012	+.048	+.012	-.029	-.056	+.004
10. Head breadth	.167	.377	.132	.045	.073	.184	.284	.637	.185	...	-.007	+.027	-.008	-.029	-.020	-.002	-.011	-.002	+.023	-.023
11. Head height	.295	.378	.132	.173	.115	.243	.238	.571	.416	.448	...	+.023	-.019	-.016	-.003	-.011	-.004	-.012	+.022	+.005
12. Minimum frontal	.264	.548	.212	.232	.175	.283	.166	.511	.304	.380	.351	...	-.082	-.061	-.001	-.019	-.029	-.005	+.035	+.019
13. Bizygomatic breadth	.305	.287	.344	.229	.240	.406	.358	.610	.388	.600	.299	.521	...	+.013	+.038	+.030	+.008	+.022	-.009	+.047
14. Bigonial breadth	.252	.312	.182	.203	.199	.213	.206	.221	.139	.238	.082	.162	.411	...	+.032	+.009	+.005	-.011	-.016	+.027
15. Face height	.330	.299	.231	.292	.300	.263	.176	.186	.234	.022	.129	.062	.244	.190	...	+.008	-.054	-.048	-.034	-.004
16. Upper face height	.245	.292	.157	.233	.249	.163	.067	.158	.177	.000	.115	.000	.158	.161	.807	...	+.024	-.019	+.002	-.019
17. Nose height	.205	.097	.156	.177	.220	.118	.063	.112	.152	-.049	.000	-.060	.145	.170	.645	.834	...	+.008	+.008	+.001
18. Nose breadth	.113	.122	.205	.183	.097	.149	.085	.217	.270	.091	.110	.139	.164	.125	.200	.150	.115	...	+.040	-.008
19. Ear length	.306	.271	.214	.203	.222	.174	.170	.145	.132	.127	.177	.130	.165	.199	.129	.131	.056	.024	...	-.014
20. Ear breadth	.066	.055	.073	.161	.101	.104	.039	.035	.010	-.014	.000	.057	.020	.184	.136	.133	.063	.039	.421	...

table, the residuals remaining after the extraction of 7 centroid factors.⁴ The matrix of these factors is shown in table 5. Direct rotation by the method of Harris ('48) was undertaken, by using vectors of the most likely measurements to locate the primary axes. The choice of these was made from plots of the extended vectors, which indicated the following

TABLE 5
Centroid factor matrix, F

	F _I	F _{II}	F _{III}	F _{IV}	F _V	F _{VI}	F _{VII}
1. Stature	.772	— .288	— .469	.033	— .106	.057	— .068
2. Sitting height	.685	.124	— .327	.349	— .091	.411	— .285
3. Upper arm length	.615	— .308	— .338	— .142	.040	— .227	— .052
4. Lower arm length	.665	— .388	— .342	— .234	— .010	— .121	— .075
5. Lower leg length	.678	— .428	— .332	— .211	— .060	— .221	— .170
6. Biacromial br.	.524	.054	— .072	.067	.029	.039	— .098
7. Bi-iliac breadth	.498	— .076	— .307	.061	.152	— .134	.122
8. Head circumference	.650	.581	.166	— .215	— .099	— .113	.179
9. Head length	.576	.343	.234	— .506	— .423	— .124	— .116
10. Head breadth	.444	.523	— .071	.132	.174	— .117	.346
11. Head height	.464	.359	— .082	— .082	— .153	.184	.332
12. Minimum frontal	.480	.433	— .143	.029	.030	.135	— .101
13. Bizygomatic br.	.638	.385	.051	.192	.334	— .296	.028
14. Bigonial br.	.407	.061	.129	.133	.261	— .091	— .199
15. Face height	.544	— .330	.430	.273	— .221	.051	.035
16. Upper face height	.494	— .397	.545	.314	— .316	.069	.151
17. Nose height	.385	— .403	.530	.298	— .237	— .133	.075
18. Nose breadth	.270	.067	.113	— .092	— .055	— .075	— .131
19. Ear length	.371	— .124	.068	— .177	.361	.357	.033
20. Ear breadth	.203	— .189	.217	— .211	.403	.319	— .052

measurements as those to be used: sitting height, lower leg length, head length, head breadth, bigonial breadth, nose height, and ear breadth. Figure 3 shows a representative plot, of factors F_{II} and F_{IV}; and this also shows the manner

⁴ Eight factors were extracted originally, indicated as possible by the extended vector plots; the 8th factor appears insignificant, however, and attempts to invert a matrix of correlations, T'T, as a step in rotation to oblique structure, based on 8 factors, indicated that this matrix was singular; i.e. that one factor involved was not in fact independent of the others.

in which relationships between measurements are suggested: e.g. head circumference (8) lies consistently between head length (9) and head breadth (10), as a linear combination of factors located by these; stature (1) similarly lies between sitting height (2) and lower leg length (5); and bizygomatic breadth (13) between head breadth (10) and bigonial breadth (14). The oblique factor matrix obtained, P , was transformed to the simple-axis type of solution, V , preferred by Thurstone (see Harris and Knoell, '48). Further rotation of two factors⁵ modified this solution slightly to the final V matrix of oblique factors shown in table 6. In table 7, finally, is given the transformation matrix, \wedge , which will transform the orthogonal factors, F , into this matrix, V .

FACTORS

V_2 (located by sitting height). This apparently represents *general size*, more or less undifferentiated but with emphasis on trunk height and at any rate with some emphasis on body measurements. Loadings are found above all for sitting height; also for stature, shoulder breadth (?), minimum frontal breadth and head height; not, however, for pelvic breadth.

This first factor at once introduces two specific difficulties, which point out general lessons in the application of factor analysis to anthropometry. In the first place, sitting height is a most unfortunate measurement for use, combining spinal and cranial heights and thus defeating the purpose

⁵ As stated, the method of rotation employed uses the vectors of chosen measurements to locate the primary axes of the oblique factors, which are therefore colinear with those measurements; the latter therefore have readings only on their respective axes, and zero loadings on all others. Negative loading of some size appeared in the columns of V_9 and V_{14} , indicating obvious simple rotations, both against V_{10} , and suggesting that these axes are properly located in positions other than colinear with the vectors for head length (9) and bigonial breadth (14). This move results in practical elimination of the negatives, and also in positive loadings on both for head breadth (10), which is obviously a more reasonable solution than a zero loading for head breadth on a factor associated with head length.

of locating possible separate factors of growth. It is perhaps this inclusion of cranial height in sitting height which causes not only the loading for head height but also that for frontal breadth and the very minor ones for facial heights. In the second place, this set of measurements includes only

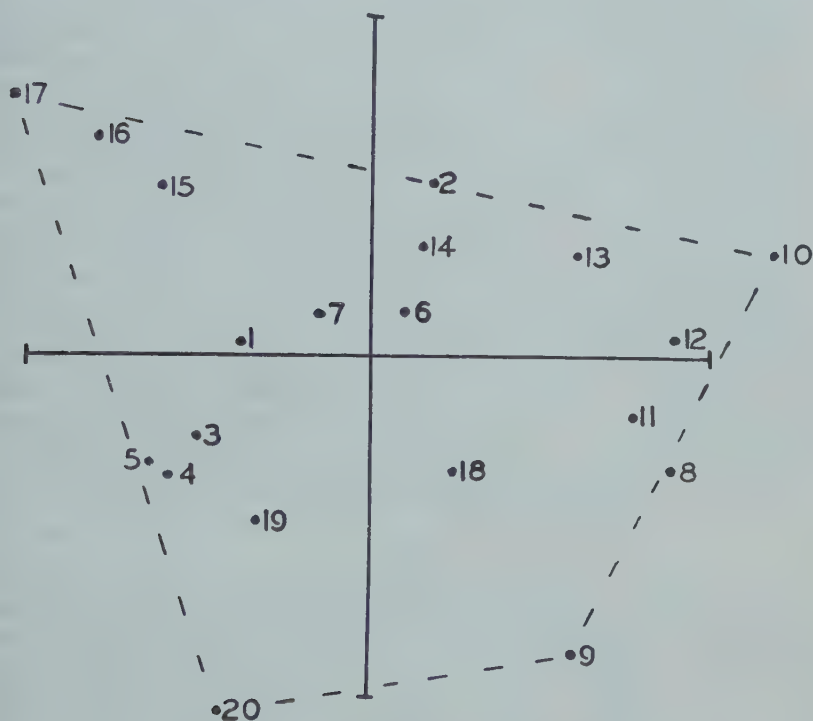


Fig. 3 Extended vector plot, F_{II} and F_{IV} .

three measures applicable to the trunk, including the unsatisfactory one of sitting height, and thus, as has already been pointed out, the defining of more than one trunk factor is precluded. The surprising thing is the failure of shoulder and pelvic breadth to register significantly on this factor.

Accordingly, recognition of the nature of this factor cannot be anything but extremely general. However, it seems to correspond with similarly indistinct factors of undifferenti-

TABLE 6
Oblique factor matrix, V (simple-axis solution)¹

	V_2	V_5	V_9	V_{10}	V_{14}	V_{17}	V_{20}
1. Stature	.37	.61	.00	.16	— .04	.07	.05
2. Sitting height	.78	.00	.00	.00	.00	.00	.00
3. Upper arm length	— .04	.67	.01	.14	.12	— .02	.01
4. Lower arm length	.03	.71	.04	.09	— .02	.00	.11
5. Lower leg length	.00	.74	.00	.00	.00	.00	.00
6. Biacromial br.	.21	.12	.13	.10	.17	.03	.03
7. Bi-iliac breadth	.02	.45	.01	.33	.26	.01	.02
8. Head circumference	.00	— .06	.80	.42	.40	.03	.06
9. Head length	.00	.00	.84	.00	.00	.00	.00
10. Head breadth	.00	.00	.41	.61	.55	.00	.00
11. Head height	.25	.01	.54	.48	.07	.10	.19
12. Minimum frontal	.31	— .08	.33	.16	.24	— .18	.00
13. Bizygomatic br.	— .10	.06	.25	.38	.76	— .02	— .10
14. Bigonial breadth	.00	.00	.00	.00	.38	.00	.00
15. Face height	.20	— .01	.07	.03	— .04	.69	.10
16. Upper face height	.19	— .05	.09	.07	— .12	.87	.13
17. Nose height	.00	.00	.00	.00	.00	.76	— .01
18. Nose breadth	.00	.01	.19	— .05	.09	.01	— .02
19. Ear length	.12	.09	.08	.15	.03	.00	.56
20. Ear breadth	.00	.00	.00	.00	.00	— .01	.56

¹ Loadings of .20 or higher are shown in boldface for convenience in reading.

TABLE 7
Transformation matrix, A

	λ_2	λ_5	λ_9	λ_{10}	λ_{14}	λ_{17}	λ_{20}
I	.226	.316	.368	.298	.272	.229	.168
II	.106	— .534	.554	.203	.416	— .402	— .223
III	— .242	— .563	.269	— .145	.094	.521	.219
IV	.382	— .291	— .536	.048	.262	.411	— .424
V	— .356	.086	— .330	.199	.598	— .361	.389
VI	.748	— .398	.021	— .050	— .562	.047	.648
VII	— .214	.219	.297	.897	.050	.462	.351

ated general size appearing in other studies, already described, where the emphasis is more on measures of the body than of the head (e.g. Thurstone, '46b, '47a).

V_5 (located by tibial length). Clearly this is the *long bone* factor also evident in all studies to date, and obviously well-

defined. Stature has a high loading on it, of course, as well as the limb segments; it is more suggestive that pelvic breadth has a significant loading while shoulder breadth has not.

V_9 (originally located by head length, later rotated). This appears to represent *general cranial size*, with emphasis on the sagittal plane to a slight degree. All measures of the cranial vault have loadings on it.

V_{10} (located by head breadth). This expresses lateral cranial development, or vault fullness, but the factor involved definitely appears to be *brain size*, rather than skeletal size as in the case of V_9 . Strong evidence for this will appear in a following section. The factor has loadings for head breadth and circumference, and head height, and suggests expansion of the parietal region. However, bi-iliac diameter is also represented on this factor, something not easy to interpret; nevertheless it is to be noted that among the original correlations, in table 4, head breadth has a higher r with bi-iliac than with head length, or bigonial breadth, or most of the other measurements which located independent factors in this set.

V_{14} (originally located by bigonial breadth, later rotated). This appears as *lateral facial-cranial development*, distinct from V_{10} , seemingly in suggesting lateral skeletal rather than encephalic growth: it shares with V_{10} loadings for head breadth, head circumference and pelvic breadth, but it has no loading for head height and is special in its loadings for bizygomatic and bigonial widths.

V_{17} (located by nose height). This is simple: *facial length*. The highest loading is for upper face height, rather than for total face height; this may be of no consequence, or may indicate factors relating to the teeth which are not tested, of course, in this set. It is interesting that no relation to V_5 , long bone length, is evident; the type of rotation used would produce mutually low loadings for the measurements involved, but the fact remains that the factors are quite distinct, and their cor-

relation (see table 8) is low, as are the correlations of the two sets of measurements themselves (table 4).

V_{20} (located by ear breadth). This also is simple: *ear size*. The only significant loadings are ear length and breadth; no other connections are visible, and the factor itself seems practically uncorrelated with all others, excepting the lateral head factor V_{14} (see table 8).

MEASUREMENTS

Looking across the rows of table 6, rather than down the columns, is instructive, especially for anthropometrists; in fact, a main source of the writer's interest in this kind of analysis is the desire for new views on ancient methods.

Stature. This, as has been abundantly illustrated in previous analyses, is not an entity, but a varying combination of limbs and trunk (the higher loading here is on V_5 , for limbs, probably not an important matter). Stature will go on being used, of course, because it is the easy, summary, measurement of the body; but it is to be hoped both that other measurements will be further exploited as size indices (Schultz has always based his primate material on *trunk length*) and that a more critical understanding will develop of the meaning of stature and size statistics (see Tanner, '47). Man is a straightened-out quadruped, with a trunk and limbs, and we may be blinding ourselves to a great deal if we persist, in all large scale work, in measuring him as though he were a snake.

Sitting height. This has been discussed under V_2 . It has a loading on this factor only, and gives the appearance of being factorially simple. This should not be relied on.

Upper arm length. In this set, a simple function of V_5 , long bone length.

Lower arm length (radius, direct measurement). The same.

Lower leg length (tibia, direct measurement). The same.

Biacromial breadth. The fact that this has no high loadings is surprising from the anatomical point of view; it is to be seen in table 5, however, that biacromial has negligible

values on all the centroid factors except the first. It might be expected to have more of a loading on V_2 (located by sitting height) and to be otherwise related to sitting height and pelvic breadth. That this is not so suggests that V_2 is not a factor specific for the trunk.

Bi-iliac breadth. Unlike shoulder breadth, this has more positive relationships, both with limb length (V_5) and with lateral development of the head (V_{10} , V_{14}), which are actually the only lateral factors in this lot; here again the paucity of trunk measurements precludes trunk factors and hence definiteness.

Head circumference. As would be expected this, like stature, is not a simple effect, but a combination of factors for head size and lateral development. Its position in figure 3 may be noted. Its high loading on V_9 indicates that this factor may be looked on as a rather generalized one of head size.

Head length. A simple function of V_9 , head size (sagittal ?). I.e. it is dependent on the growth of the general cranial skeleton, and not the brain. (Note, as already explained in a footnote, that head length was used to locate one of the primary axes, but this axis later required further rotation, indicating that its associations were more general than with head length alone.)

Head breadth. A resultant of head size, brain size, and lateral development (V_9 , V_{10} , V_{14}).

Head height. Apparently this is a resultant of general cranial skeletal size and of cranial (cerebral) width, or brain size, and also V_2 , though this last should be looked on as spurious.

Minimum frontal breadth. Also of complexity two (or three ?). A combination of general cranial size and lateral (facial-cranial) development. The loading on V_2 (general size) is interesting; conceivably it comes through the inclusion of the head height in sitting height, but not necessarily. Notice the original high r of .548 between sitting height and minimum frontal, in table 4. (Head length and head breadth

have zero loadings on V_2 , from the rotation used, but this does not apply to head circumference, and this also has no loading on V_2 ; yet if forehead breadth owes its loading on V_2 to a link with sitting height directly via head height, this should affect head circumference as well. This seems to be another sign of the non-specific nature of V_2).

Bizygomatic breadth. This is of complexity three here: general cranial size, and lateral development (cerebral and cranio-facial). V_{14} has the highest loading.

Bigonial breadth. Simple, for this set. It was used to locate V_{14} , but this axis was later moved.

Face height. In this set, a simple function of facial length.

Upper face height. The same.

Nose height. The same.

Nose breadth. No loadings of apparent significance. This is true also, as in the case of biacromial breadth, of its values in the centroid factors, table 5. Note that there appears to be no special factor for "nose size," relating to the principal diameters, as there is for ear size.

Ear length. A function of ear size (V_{20}) alone.

Ear breadth. The same.

SECOND ORDER FACTORS

This is a question of the relationships of the factors themselves, which may be an important matter in data of this kind. Table 8 gives the intercorrelations of the oblique factors (primary axes).⁶

The fact of outstanding interest is the negative correlation of factor V_{10} with all other factors.⁷ So startling was this

⁶ This matrix, ϕ or $D(\Lambda'\Lambda)^{-1}D$ (see Harris and Knoell, '48; Thurstone, '47b, p. 215) is derived from the transformation matrix of directional cosines, Λ , which was constructed after the original rotation and the further rotations of V_9 and V_{14} .

⁷ V_9 and V_{14} had negative loadings after the first, direct rotation; rotating the simple axes for these, both of them against V_{10} , to eliminate the negatives in effect rotated the primary axis of V_{10} to a new position, where it is highly special, forming an obtuse angle (having negative correlations) with all the other primaries. The fact that this produces a reasonable oblique solution, without negative loadings of consequence, nevertheless indicates that this is a correct relationship, not reached on the first rotation.

finding, in fact, that it was considered likely that the secondary rotations of V_9 and V_{14} , which were responsible for this shift in the primary of V_{10} , had been too drastic, or poorly chosen. Further attempts at rotation were accordingly made, but these did not effectively reduce the negative correlations of V_{10} and only produced less satisfactory solutions in V_9 and V_{14} . Furthermore, it may be noted in table 4 that the original correlations of head breadth are low, and sometimes negative, with the other key measurements (something which was also reflected in the correlations of the factor V_{10} in the Φ matrix of the original direct rotation, not

TABLE 8

Intercorrelations of factors [$D(\Lambda'\Lambda)^{-1}D = \Phi$]

(Upper half of table shows third factor residuals for second order centroids)

	V_2	V_5	V_9	V_{10}	V_{14}	V_{17}	V_{20}
V_2	1.000	— .028	— .009	+ .046	+ .035	— .010	+ .001
V_5	.443	1.000	— .004	— .002	+ .065	+ .029	— .037
V_9	.210	.371	1.000	+ .048	— .030	— .039	+ .038
V_{10}	— .255	— .505	— .450	1.000	+ .025	— .007	— .071
V_{14}	.515	.409	.255	— .603	1.000	— .060	+ .019
V_{17}	.104	.273	.189	— .446	.354	1.000	+ .070
V_{20}	.126	.170	.008	— .428	.424	.127	1.000

shown in this paper). Taken all together, the evidence is good that these negative correlations are quite correct, and that the rather drastic removal of the primary axis of V_{10} from the other factors is proper.

In interpretation, this means that this factor, first located by head breadth, is something "beyond" head breadth, and is something expressed only partly, and almost alone, by head breadth and head height. Also, it is especially antithetical to V_{14} , which is associated with breadth and ruggedness of the facial (and basal ?) skeleton. The suggestion is therefore very strong that V_{10} does indeed represent brain size, and that this is so slightly correlated with, or has so great a lag on, either body size or general head size that, as

a factor — more distinct than simple head breadth — it actually has negative correlations with the others. If this conclusion is justified, it is perhaps the most significant finding from the present analysis.

It is possible to use the correlations of the factors to find factors of the second order (see Thurstone, '47b, ch. XVIII); i.e. factors of factors, which may help further in comprehension of the primary factors. After reflecting V_{10} at once (changing signs and keeping V_{10} itself as a minus variable), three centroid factors were extracted, the result being shown in table 9. The third factor residuals appear in the upper portion of table 8, and indicate that the number of factors and the solution are satisfactory.

TABLE 9
Second order centroid factors

	I	II	III
V_2	.508	— .301	— .327
V_5	.655	— .309	.033
V_9	.446	— .237	.296
V_{10}	— .843	— .173	— .228
V_{14}	.809	.145	— .345
V_{17}	.438	.165	.243
V_{20}	.382	.366	— .124

These second order factors are treated in three simple ways in figure 4 and table 10. Figure 4 is a plot of the extended vectors of the primary factors, entirely comparable in nature to the plot in figure 2. If, in figure 4, V_2 , V_9 , and V_{20} are taken as the corners of a triangle, and as locating the primary axes of the second order factors, it is easy to jot down the pattern which would be obtained by a rotation to oblique factors; this pattern is shown in table 10. This indicates that V_2 , V_9 , and V_{20} would each be of complexity one — described by a single factor each — and that the remainder would be of complexity two — combinations of two factors — while V_{17} would have a negative loading on the factor located by V_2 .

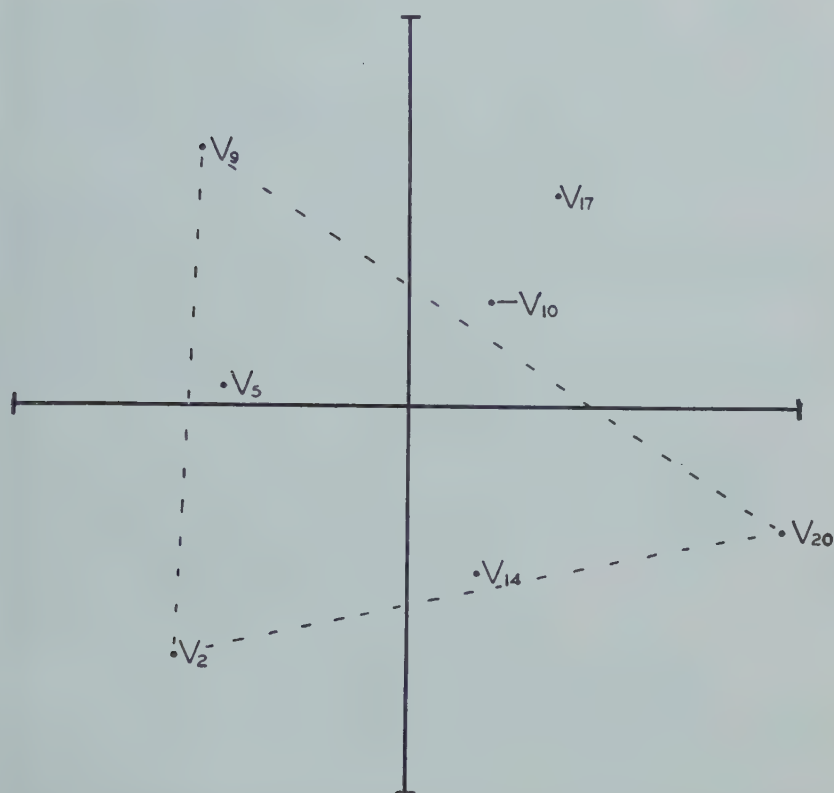


Fig. 4 Extended vector plot, first order factors on second order factors.

TABLE 10

Second order factor pattern

	PATTERN EXPECTED FROM PLOT, FIGURE 4			ORTHOGONAL ROTATION OF FACTORS		
	I	II	III	I	II	III
V ₂ general body size	X	--	--	.68	.00	-.01
V ₅ long bone length	X	X	--	.62	.38	.05
V ₉ cranial (skeletal) size	--	X	--	.30	.51	.01
V ₁₀ brain size	--	-X	-X	-.46	-.51	-.56
V ₁₄ lateral facial-cranial dev.	X	--	X	.72	.01	.52
V ₁₇ face length	-(X)	X	X	.15	.36	.36
V ₂₀ ear size	--	--	X	.20	-.03	.51

Actually, a simple orthogonal rotation (Holzinger and Harman, '41, ch. X) will produce this result without the negative: this solution is given in table 10. The expected pattern, indicated by the plot and also shown in table 10, appears, and all may be used together in interpretation.

The first factor has positive loadings except for V_{10} throughout, and may be taken as a general factor in the usual sense (though this might not appear in alternative solutions). Its high loadings are for V_2 , V_5 , and V_{14} , or general size (trunk ?), long bone length, and lateral skeletal (cranio-facial) development; i.e. it is a factor of *general skeletal size* with, if you use such language, overtones of mesomorphy.

The second factor, with three zero loadings and with positive loadings on V_5 , V_9 , and V_{17} seems to emphasize *linear skeletal growth* (long bones, general (sagittal ?) head size, facial length); brain growth is negative (lags very markedly); general size and lateral skeletal (cranio-facial) development are lacking. If this be ectomorphy, make the most of it; this is not a notion which appeals to the writer, in view of the negative relation to brain size.

The third factor is certainly puzzling, involving the mysteriously negative V_{10} . It is associated with the head, certainly, but excludes V_9 general head size (sagittal ?) proper, and is negative for V_{10} , brain size. It is really facial, and antithetical with cerebral growth. Even V_{17} is anomalous in position in this group of factors, as the plot of figure 4 shows. The main emphasis of this factor seems to be on facial (cranial skeletal?) laterality, but on face size anyhow.

As to Sheldonian typology, the above may be taken for what it is worth. No direct dovetailing is possible, because the measurements used herein, like those of the typical anthropometric schedule, relate almost entirely to the skeleton and cannot be expected to reveal endomorphy. Nevertheless, it is suggested that constitutionalists anxious to arrive at a validation of their concepts by work with measurement and statistics might use methods allied to those described above.

Waldrop has reported on such work ('40), but apparently without publication.

Finally, some of my colleagues, particularly in England, may smile at seeing the second order factors develop, according to appearances, as "general," "linear" and "lateral" (?); in other words, to come out after a long way round at conclusions not unlike those arrived at from primary centroid and bipolar factors, in several studies. The fact is, however, that the more extended treatment of factors, with rotation, allows a greater insight into the nature and relations of the measured traits under study, and is more suggestive of possibilities for work on specific lines. Tools, not only for following out new conceptions of the organization of growth and of genetic and environmental quantities, but also for prying open some of our crusted habits of method for re-examination, are what we badly need.

CONCLUSIONS

In general, while factor analysis has been applied a number of times to anthropometric data, no study (including the present one) has been planned from the beginning to take full advantage of the technique. The actual field open to it is therefore not clear.

In this study, as in former ones, the generally accidental selection of measurements used has probably resulted in under-determination of factors. That is to say, in the present case three limb measurements were included, as were three facial length measurements, resulting in distinct and apparently unitary factors for limb and facial length; thus in general the constitution of factors has probably depended more on the measurements than on true growth patterns. This being so, it may be that the second order factors are of more general significance than the primary factors.

For the head and face, however, there were enough measurements to allow the appearance of suggestively distinct fac-

tors within one field. The clear division between brain size and skeletal factors in the head, if valid, is certainly important.

Taking together the nature of all the factors found, it seems likely that intensive studies of limited regions or features, rather than general, unrestricted sets of measurements, may give the most useful immediate results by factor analysis.

SUMMARY

There is a need for further analytical techniques, especially statistical ones, in anthropometry. Factor analysis is discussed as one such technique.

An analysis is made, based on 152 Wisconsin students, of a set of measurements largely of the head and face. Seven factors are found, interpreted as general body size, long bone length, cranial (skeletal) size, brain size, lateral facial-cranial development, face length, and ear size.

The factors found necessarily depend greatly on the set of measurements used, and in the case of at least three, possibly four, factors all that can be said is that certain groups of measurements are factorially distinct and independent (long bone length, face length, ear size).

In the cranial vault and facial breadth, however, more meaningful factors appear, especially in the distinction between brain size, head size, and lateral development; and above all between brain size and all other factors of this set.

Some comments are possible on the significance of certain measurements. Head length appears as principally associated with general head size, and *not* with brain size, while head breadth is associated principally, or at least strongly, with brain size. This may explain the fact that these two measurements have always been found to have a relatively low correlation. Stature, head circumference, and to a great extent bizygomatic breadth, are complex measurements, reflecting the influence of more than one basic factor.

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ABORIGINAL MAORI POPULATION.— Estimates made after 1830 are in general agreement that numbers totalled 150,000 or more in the 'thirties. Craig, Polack, Yates, Wilkes, Wade and Terry support this, and Baring, summing up evidence presented to a Parliamentary Commission [1838], said the best estimates did not exceed 150,000. But Polack also said there were not more than 130,000, and others who based their figures on local assessments and were therefore less likely to err, supported a lower estimate. Williams thus concluded that there were 106,000 in the North Island. Hinds suggested 105,000. Hamlin's estimate of 120,000 was based on a more detailed count than that of Williams. Colenso stated there were 40,000 warriors in the North Island in the late 'thirties, which suggests a total of 120,000 if Hamlin's practice of multiplying warrior numbers by three be followed. The South Island contained, at the most, a few thousand. Dieffenbach's detailed analysis, resulting in the conclusion that there were 114,890 natives in 1843, confirmed these earlier estimates. It thus appears that there were approximately 120,000 Maori people in New Zealand when the treaty of Waitangi was signed more than 70 years after Cook first examined the coasts of Aotearoa. . . .

The opinions of modern authorities support the conclusion that the number of Maori people had been considerably greater than it was in 1840 . . . Best considers that the ruins in the north "show that the country must once have supported a large population. But our information is not precise enough to enable us to speak with any certainty." Duff suggests population was about 165,000. Fisher thinks it was between 200,000 and 300,00. Buck asserts it numbered at least 200,000 and not improbably 500,000, though he seems to prefer 400,000. Cumberland claims that Aotearoa had the resources to support 1,000,000 at the Maori's neolithic culture level and suggests that "the island might well, at times, have sustained a population considerably larger than half this number during the eighteenth century" . . .

. . . But these results [consideration of districts observed by Cook] coincide with an impression gleaned from general evidence that, at the time of Cook's visit, about a quarter of a million Maori dwelt in Aotearoa.— Gordon Lewthwaite. The population of Aotearoa: its number and distribution. *New Zealand Geographer*, vol. 6, pp. 35-52. 1950.

THE DEVELOPMENTAL GENETICS AND EVOLUTIONARY MEANING OF THE METOPIC SUTURE

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TWENTY-TWO FIGURES

INTRODUCTION

The only observation of familial occurrence of the metopic suture is Welckers (1862). He observed it in two brothers. The geographical distribution has been dealt with by several authors. Comas ('42) gives a critical review of the literature on this subject. On the basis of observations in American crania Sullivan ('22) concluded that metopism is "(citation¹). . . ." Ashley-Montagu emphasizes ("citation². . .")

It is, according to this author, unnecessary to assume that the persistence of the metopic suture represents either an adaptive or a selective variation. He supposes that the incidence of metopism depends on a simple genetic mechanism and hybridization. According to Schultz ('29) the metopic suture and fissure probably have a different genetic basis.

Ashley-Montagu is of the opinion that evidence concerning the direct heritability of metopism in man is in the nature

¹"a local characteristic, for some cause or causes arising in a given group and transmitted by heredity. Its frequency is determined largely by its dominance and length of time since its appearance in the group"

²"that incidence of metopism varies with locality, locality being almost invariably equivalent to racial variety in this connection. The inference at once suggests itself that the incidence of metopism in any one racial variety is in some way connected with the factors which are responsible for the differences existing in certain other and more marked physical characters between varieties of the same race"

of the case exceedingly difficult to obtain. This study is meant as an approach to this problem. A thorough knowledge of the radiology of the suture is a necessary basis for the study of its familial occurrence. For this reason the present paper is preceded by a study dealing with the radiologic aspect of the problem (Torgersen, '50a).

MATERIAL

The incidence of the suture was 12.8% in 1,012 skulls from medieval Oslo, 10.0% in 339 skulls from other parts of eastern Norway, and 11.1% in 370 skulls from the west. There is no difference between the longheaded population in the east and the relatively brachycephalic population in the west.

In 648 Lapp skulls the incidence is 3.2%. The frequency varies from 6.2% in 112 skulls of "skoltelapps" with a prominent Russian admixture to 1.9% in 318 presumably more pure Lapps. The "skoltelapps" show many peculiarities from a craniometric point of view (Schreiner, '35).

The suture occurred in 11.3% of 106 Nordic skulls in the age group 2-20 years and in 4.1% in 122 skulls of Lapps of the same age group. The frequency in these skulls parallels the frequency in adults.

The frequency is lower in the Lapps than in the Nordics and in the partly Alpine population in the west. The difference between the two Lapp groups is about twice the standard error. Considering other craniological differences it is reasonable to assume the presence of local variation among the Lapps as observed by Sullivan in Bolivians.

The metopic fissure occurred in 0.59% in 1,012 skulls from Oslo and 0.46% in 648 skulls of Lapps. The fissure occurred in 2% in 152 skulls with a complete metopic suture and in 0.39% in 1,508 skulls not showing the suture. The difference is not significant but indicates an interdependence of the fissure and the suture. According to Schultz ('29) the same parallelism is found in skulls of Japanese and Filipinos, the metopic suture and fissure showing an incidence respectively of 7.8% and 6.2% in Japanese, and of 2.2% and 0.3% in Filipinos.

In 310 skull roentgenograms from Oslo metopism was found in 16 cases. Five of the parents and 11 siblings of 4 of these individuals were examined. These findings were negative.

In 4 other families, A, B, C and D, the suture was found to be hereditary. Family A was discovered in a study of visceral inversion. During a study of the hereditary factors in this anomaly it came out that visceral inversion in not a few cases may be produced by genes influencing the development of the lungs and the frontal sinuses. The metopic suture was found three times in 20 cases belonging to this group.

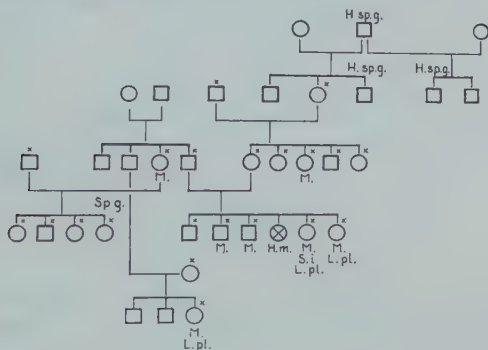


Fig. 1 Family A. M, metopic suture; H, harelip; Sp.g., cleft palate; Si., situs inversus; L.pl., lingua plicata; H.m., heart malformation; X, individuals examined. (See also figs. 5-12.)

The genes involved manifest themselves as underdeveloped frontal sinuses and bronchi and visceral inversion (Torgersen, '49b).

One of these cases was a girl 16 years of age. The pedigree (fig. 1) shows the occurrence of the suture in this family and figures 5-12 the roentgenograms of the frontal bone. Seven members, all above 13 years of age, certainly showed a metopic suture. It is most probably present also in the mother in the stage of closure. The members with the suture show the metopic forehead with a frontoparietal index of 71.33 ± 0.97 as against 67.73 ± 2.7 in 7 other members. This

index in the mother is 69.86 and her cephalic index is 80.56. The cephalic index is 81.60 ± 2.8 in the members with the suture, 80.61 ± 1.2 in 7 other members. It was 86.03 in one of the brothers with metopism. These indices are surprisingly high considering that the ancestors have lived in the vicinity of Oslo as far back as is known. The mean index in this population is 78.0.

A furrowed tongue was found in both sisters and in a paternal cousin, all of whom had metopism. One of the sisters had notched incisors. Another sister had died in infancy, probably from congenital heart disease with cyanosis. The spine was examined in the parents and the 5 siblings.

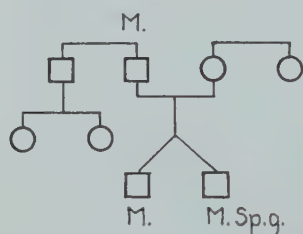


Fig. 2 Family B. M, metopic suture; Sp.g., cleft palate. All individuals examined. (See also figs. 13-15.)

The father and two brothers show a spina bifida occulta. The incidence of this anomaly in 400 roentgenograms is 9.6%.

Harelip and cleft palate occurred on the maternal side of the family. Cleft palate occurred also in a paternal cousin, the mother of whom showed metopism.

The suture was found 5 times in 75 individuals between three and 20 years of age who had cleft palate, and three times in 95 of their parents and siblings. The family of two of these 5 individuals was examined and the suture was found to be hereditary in both. In family B (fig. 2) the suture occurred in both of a pair of probably monozygotic twins, 11 years of age, the only pair of twins in this series. One of them showed harelip and cleft palate. The suture was found in the father. In family C (fig. 3) the suture occurred in a

brother and possibly the father of a boy with cleft palate and the suture.

Family D (fig. 4) was detected in a series of skull roentgenograms of twins. The suture was found in a pair of dizygotic twins, 8 years of age. The father, probably the mother and a sister 14 years of age showed the suture. Only one member of the family, a sister 16 years of age, did not show the suture. No abnormalities were found in the family. Two pairs of

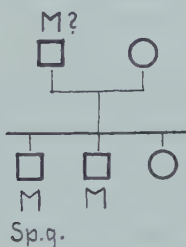


Fig. 3 Family C. M, metopic suture; Sp.g., cleft palate. All individuals examined. (See also figs. 21, 22.)

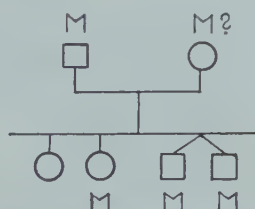


Fig. 4 Family D. M, metopic suture. All individuals examined. (See also figs. 16-20.)

twins occurred among the paternal uncles and cousins of the mother.

The cephalic index of the father is 76.14, the frontoparietal index 76 and the facial index 95.07. The corresponding indices of the mother is 80.85, 73.68 and 91.18, of the sister with the suture 81.67, 72.79 and 87.69, of one twin brother 79.55, 72.86 and 86.78, of the other twin brother 86.86, 71.71 and 82.95 and finally of the sister not showing the suture 83.80, 71.33 and 86.82. The ancestors of the mother and the paternal grandmother are from the vicinity of Oslo; the paternal grandfather is from central Germany.

DISCUSSION

The suture behaves as a dominant trait with a varying penetrance, and in many cases is sporadic in its appearance. In the families A and D taken together the ratio affected to normals is 7:2, a ratio indicating that the hereditary factors may be present both in the father and the mother. It is not unreasonable to assume that the high number of affected siblings and the extraordinary combination of anomalies in family A is due to homozygosity in dominant genes, which had a lethal effect in the case of one sibling. In all the affected siblings the genes manifest themselves in the breadth of the forehead and shortness of the face, signs of a general hypoplasia which has manifested itself in a furrowed tongue in three individuals and notched incisors in one sibling. One is also impressed by the variability of the indices in family A and D.

The concordance in a pair of dizygotic twins indicates environmental factors, or the presence of the same genes in both. There is also a third possibility. The hereditary or environmental factors in twinning may favor the manifestation of the genes in metopism. It is surprising that the suture is found as a hereditary trait in both of a pair of dizygotic twins and in the only pair of twins with cleft palate examined. The visceral inversion in family A is worth noting in this connection, due to the relationship between this anomaly and twinning (Torgersen, '49a).

The dominant gene causing cleft palate in the maternal grandfather and his children in family A is not to be expected in his normal daughter and her offspring. According to Fogh-Andersen ('42) cleft palate is not hereditary in many cases. The occurrence of the suture in the paternal aunt and cleft palate in her daughter could be supposed to be coincidental. This assumption is improbable considering the occurrence of the suture and a furrowed tongue in a cousin.

The occurrence of the suture in both of a pair of monozygotic twins one of whom shows cleft palate, and in the brother

of the boy with the suture and cleft palate, indicates an interdependence of these traits. The incidence of the suture in the series of individuals with cleft palate and their relatives is against the assumption that the suture is an expression of the genes in cleft palate.

The observations suggest that if the genes in cleft palate and metopism happen to meet in the same genotype, an occurrence which is expected to be very rare, these genes may occasionally favor the phenotypic manifestation of one another.

There is some evidence from mouse genetics of a more direct relationship between metopism and cleft palate. Gluecksohn-Schoenheimer and Dunn ('48) report cleft palate and non-fusion of the frontals in mice with short heads and "pug" nose, a skull form much like the metopic skull.

This form of the skull is found also in cleidocranial dysostosis. In this anomaly the metopic suture and fissure are frequently present. The condition which shows dominant inheritance has been dealt with by Hultkrantz ('08). One of the first cases reported showed situs inversus, a finding indicating that the occurrence of visceral inversion and the suture in family A is not due to chance. Spina bifida occulta and anomalies of the teeth are frequently found in cleidocranial dysostosis. The occurrence of the same anomalies in family A indicate a relationship to the genotype in cleidocranial dysostosis in this case.

Cleidocranial dysostosis is of interest relative to the relationship between the suture and the fissure. According to Schultz ('29) both have the same influence on head form. One of the skulls described by this author is possibly a manifestation of a genotype related to cleidocranial dysostosis, which in many cases may manifest itself only in the skull, as suture bones and anomalies of the teeth and nasal bones, as observed by Schultz in this skull. Suture bones are common also in the metopic skull. The suture with the fissure (Welcker, 1862), and the fissure alone (E. Fischer, '02) have been observed in cretins. The suture is relatively frequent

in congenital myxoedema (Torgersen, '50a). Both cleft palate and the suture are expressions of a hypoplasia of the skeleton of the face and forehead. The genes involved in these traits may be supposed to accentuate each other. The frontal bone is thin in the presence of a metopic suture, and the frontal sinuses are small (Rochlin and Rubaschewa, '34). The increased frontal curvature which is found in the metopic skull (Woo, '49) is found in a defective development of the bones generally as in cretinism, rickets and cleidocranial dysostosis. The variability of the indices in the families A and D indicates that the suture may be of importance in the adjustment of the facial skeleton to the forehead.

The same form of the skull is seen in hereditary ectodermal dysplasia, which affects the bones of the forehead and face (Thannhauser, '36; Knorre, '37). In this condition small sinuses and atrophy of the tissues of the upper respiratory tract are rather common. In previous studies (Torgersen, '47, '49a, b) the author has reported observations which indicate that the development of the frontal sinuses and lower respiratory tract partly depend on the same genes.

The characteristics of the metopic skull, which is caricatured in cleidocranial dysostosis, are in accordance with the trends of the evolutionary transformation of the human skull, the recession of the face, the increase of the frontal curvature, the increase of the distance between the eyes and the thinning of the bones. The sutures close late in the metopic skull (Torgersen, '50a), also a trend in human evolution.

This evolutionary trend is an adaption to the erect posture. This is also the case with the variations of the asymmetry of the viscera which is important to the fixation of the mesentery. The relation to the development of the viscera, particularly the respiratory tract, indicates that the suture has a selective value.

The geographical distribution expresses the genetic variability and has, as seen clearly in Norway, no correlation to brachycephaly, but to the process of brachycephalization. The genetic variability indicates the varying speed of the

transformation of the skull. In the Australians the process has probably not yet started. In the Lapps it is far advanced and the metopic suture about to lose its evolutionary significance. The Lapp skull and the metopic skull both tend to return to what Abbie ('47) calls the paedocephalic, primary, infantile form in which sexual distinction also is eliminated. The high frequency of the suture in Western Europe is in accordance with the observation that the process of brachycephalization is progressing rapidly. The suture may be supposed to be due to dominant genes in the same way as brachycephaly in groups in which this evolutionary process is about to start or progressing rapidly, tending to be a recessive trait and again rare in groups like the Lapps who show the form of the metopic skull without any suture.

The very slightly variable pterion pattern in the Lapps (Schreiner, '35) is the contrast to the variability of the metopic skull in this respect (Comas, '42), a fact indicating that the Lapp skull is in a more stable stage of evolution than groups in which the metopic suture is frequent. A parallel to this evolutionary trend in man is found in the pigmy chimpanzee, which shows a human pterion pattern and a relatively frequent metopic suture (Weidenreich, '48).

The hereditary factors in the metopic suture may be supposed to be related to the genes influencing the growth of the forehead and particularly the growth in breadth, which is a trend of human evolution. The genes affecting growth in breadth, and the hereditary factors in bilateral symmetry or in the symmetrical expression of the genes, may be supposed to be related or identical. It is also reasonable to assume a relationship to the factors in the asymmetry of the viscera.

The genes influencing symmetry represent a principle in human genetics and in vertebrate evolution. They are essential to the suppression of the symmetry of the gill arches in the development of lung respiration, a fact revealing itself in the developmental genetics of heart defects in man (Torgersen, '50b). These mutations also reveal their effect

in the adaptation to the erect posture, in the variations of the asymmetry of the viscera, in the growth in breadth, and in the metopic suture.

The opposite of the metopic skull concerning breadth is the cyclopic or trigonocephalic skull in which the medio-frontal suture is either absent or closes very early. The metopic suture may be supposed to have a relationship to the adaptation of the visual axes to the growth in breadth of the body and the field of action of the hands. It may further have a relationship to characters connected with the visceral part of the skull, respiration and metabolism.

The occurrence of the suture in hypothyroidism indicates that one of the selective factors may have been the available iodine and the thyroxin demand of the organism. In the case of iodine deficiency, mutations causing a low thyroxin demand would be favored by selection. These mutations may concern the reactivity of the tissues of the forehead to the hormone and manifest themselves in a cretinoid face. The many signs of hypothyroidism in the Lapps may indicate that environmental factors of this nature have initiated the evolutionary trend of this group.

The form of the face in the two extremes of skull, the metopic and the cyclopic, reflects the size of the ethmoid. According to Welcker the olfactory tracts are regularly missing in cyclopia.

The opposite of the metopic skull in the matter of thickness of the bones and size of the frontal sinuses and the superstructures is the acromegalic skull. The hypophyseal fossa is infantile in the metopic skull (Rochlin and Rubaschewa, '34). The hereditary factors in the metopic suture take effect in the prechordal part of the skull, the hypophyseal fossa and the parts of the brain concerned with vital metabolic and sensory functions. The chordal and prechordal embryonic field meet at the basal angle and the hypophyseal fossa. The variations in this angle are important to the increase of the frontal curvature and to the recession of the face which are trends of human evolution and characteristics of the metopic skull.

An opposite of the metopic face and forehead is found also in microcephalics. The similitary of the face in acromegalics and microcephalics, and the frequent early suture closure in the latter, indicate that the large brain of man has a depressing influence on the growth of the face and on suture closure, probably mediated by the pituitary.

According to Kjellgren ('44) there are more fibers in the nerve roots on the right than on the left side. In a study not yet published of 404 hand roentgenograms I have found that the ossification was more advanced in the left than in the right hand. The difference was 9 ± 2.7 per cent. Abbie ('50) found that the suture closure was more advanced on the left side. Probably a higher ossification rate on the left is the cause of the frequent deviation of the metopic suture to the right of the bregma. The consistency of the observations is rather good evidence that the nerve supply and probably also the brain has an influence on ossification rate, suture closure and skull form. Probably this effect of the brain and nerves is mediated, at least partly, by the blood supply.

At the fore end of the body there have developed the sense organs and the visceral parts of the skull which have been the most important in determining reactions in response to changes in the environment. The course of evolution is first of all conditioned by the brain stem, the face and forehead. The findings in *Australopithecus* show that a human face and forehead and probably also a human body and erect posture were achieved before the brain surpassed the simian level. Man has passed a stage in which these structures had a more immediate selective value than the psychomotor functions of the cerebral hemispheres. The hereditary factors in the metopic suture, and the developmental processes connected with it, indicate the causative factors, and the mode and tempo, of this process in evolution and in the differentiation of modern man.

SUMMARY

The incidence of the metopic suture and fissure in Norway is recorded. The suture is rare in the Lapps.

In 4 families in which the suture had been found in one member, no suture was found in 5 of the parents and 11 siblings examined.

The suture behaved as a dominant trait in 4 other families. The penetrance shows interfamilial variability probably depending on conditioning factors, among them the hereditary factors in cleft palate, symmetry and twinning. The variability of the form of the face and head in these families is very great.

Due to the probable relationship to the development of the internal organs, the eye axes, the pituitary and the brain stem, the suture has a selective value. The form of the face and forehead in the presence of the suture is in conformity with the evolutionary trend of the skull. For this reason the developmental genetics of the metopic suture indicate the causative factors, the mode and the tempo of the transformation of the skull in evolution and in the differentiation of modern man.

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PLATE 1

EXPLANATION OF FIGURES

Roentgenograms showing metopic suture.

- 5 Family A. Girl 16 years old. Situs inversus.
- 6 Her sister.
- 7 Her brother.
- 8 Her brother.
- 9 Her mother. The suture in the stage of closure.
- 10 Her paternal cousin.
- 11 Her paternal aunt. Suture in the stage of closure.
- 12 Her maternal aunt. Suture in the stage of closure.
- 13 Family B. One of a pair of monozygotic twins with the suture and cleft palate.
- 14 His twin brother with the suture.
- 15 Their father.
- 16 Family D. The father of the dizygotic twins. The suture in the stage of closure.
- 17 One of a pair of dizygotic twins with the suture.
- 18 His twin brother with the suture.
- 19 Their sister.
- 20 The mother of the dizygotic twins. The suture in the stage of closure.
- 21 Family C. Boy, 8 years old, with the suture and cleft palate.
- 22 His brother, 7 years old, with the suture.



ADDENDUM

Up to February 15, 1951, a total of 95 members of 16 families have been examined. The occurrence of the suture in 13 families in which all sibs and parents have been examined is shown in table 1.

Apparently the persistence of the mediofrontal suture depends on a dominant gene, and its obliteration on the homozygous recessive "normal" allele. The probands being excluded, the penetrance is about 50%.

In a non-selected series of 53 pairs of twins the suture was found in 8 pairs. The similarity of the twins was examined only in the cases in which the suture was found. The suture occurred in both twins in three of the 4 probably monozygotic pairs and in two of the 4 dizygotic pairs. As recorded the suture was found in both parents of one of the concordant dizygotic pairs. The discordance in one

TABLE 1

The occurrence of the metopic suture in the offspring of different mating categories

IN THE PARENTS OR THEIR FAMILIES	NUMBER OF SIBSHIPS	IN THE SIBLINGS	
		No suture	Suture
Both parents:	1	1	3
In the families of both parents:	1	1	4
One of the parents:	7	10	9
In the family of one of the parents:	1	2	3
None of the parents:	3	15	3

of the monozygotic pairs, two girls 8 years of age, suggests that the gene does not manifest itself in all cases. This may partly explain why the suture was not found in 15 sibs nor in any of the parents in three cases. In these three families all the individuals were above 40 years of age and the suture may have been obliterated. The youngest individual in the material is 7 years of age and the oldest 75 years old. Due to the late closure of the suture it was found in three generations in one family: in the maternal grandmother, 75 years old; in the mother, 52 years old; and in one of her three children, a girl 24 years of age.

In one family the suture was found concordantly in two pairs of twins in the same sibship, whereas two other siblings did not show the suture. It was also found in a paternal cousin. All these individuals were above 20 years of age. All twins had the same blood groups. Considering the blood groups of the parents the probability

that this finding is due to chance was calculated to be about 13%. In one of the pairs, two girls, the color of the iris and the hair was found to be identical. The cephalic index is 79.46 in both and the frontoparietal index 71.43. The zygoty of the other pair, two boys, is questionable. They show the same color of the eyes. The cephalic index in one of them is 84.41 and in the other 81.05 and the frontoparietal index 76.43 and 74.03 respectively. In a brother of these twin pairs the cephalic index was found to be 71.36 and the frontoparietal index 78.23. The same extreme variability regarding headshape is found in this family as in the families recorded in the preceding.

The twin families probably represent an unselected sample of the population relative to the hereditary behavior of the suture. In 6 of these families which have been examined so far the suture behaves as if its persistence was determined by a dominant gene. The fact that the incidence of the suture in these families corresponds to the incidence in the population indicates that the frequency of the metopic suture in Norway is determined by this gene.

In this connection the geographical and historical variations in the frequency of the metopic suture in Norway are of particular interest. The frequency in 407 skulls from the North (the Lapp material excluded) is 4.7% and thus lower than the frequency in the South recorded in the preceding. The incidence of the suture in 149 prehistoric skulls is 4.7%. These skulls are all of the Nordic type. Eighty-two of these skulls are from the North and show the suture in 2.4%, whereas the incidence in 67 prehistoric skulls from the South is 7.5%. Among the latter the suture was found in probably the oldest Neolithic skull from Norway and in the famous female skull from the Oseberg Viking ship. The frequencies have probably increased proportionately in the North and the South during the 800 years which, on the average, intervene between the prehistoric and the historic skulls.

The frequencies in the other countries of Europe are nowhere higher than in southern Norway. In most places the frequency is somewhat lower. Thus migrations alone can hardly explain the increasing frequency in this period. It is reasonable to assume that the increase is partly due to mutations which have a selective value.

Extensive investigations in different groups are necessary to decide whether the mutations concern the main gene or genes which condition the manifestation of this gene. The geographical variations may be assumed to depend on the frequency of the main gene or upon variations regarding the probability of manifestation. It is not justifiable to conclude that the probability of manifestation is as high in other groups as in the Norwegian population at present.

THE ROLE OF PHYSICAL ANTHROPOLOGY IN DENTAL AND MEDICAL RESEARCH ¹

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The physical anthropologist is traditionally a measurer of man in the mass. Primarily he has studied adult populations, but in recent years his attention has turned to the growth-period of the first two decades of life. He is concerned, therefore, with the external morphology of *Homo sapiens* in both a mensurational and a descriptive capacity. He is concerned also with that most tangible evidence of Man's mortality, the skeleton. He is, then, somatometrist, somatoscopist, and osteometrist. One further word must be added before we turn to more detailed observations: in measuring large samples of the population recourse has been had to statistics, to establish central tendency, normal range of variation, and to test possible inter-correlations. These mass data become, as it were, the operating framework within which—at experimental and clinical level—we place the individual case under scrutiny. It is inevitable, I think, as Physical Anthropology teams up with Medicine and Dentistry, that mass studies provide norms to make individual clinical appraisal meaningful. We must be prepared to recognize that in medical and dental research the *individual is the ultimate unit*.

Among those physical anthropologists who are trained in anatomy, either comparative or human, there is a further function that may be fulfilled, viz., the teaching and interpretation of functional morphology. This applies no less to dentists than to doctors.

¹ This constitutes the outline of Dr. Krogman's address at the Annual Dinner, March 20, during the 20th Annual Meeting of the American Association of Physical Anthropologists at Ann Arbor, Mich.

With these generalizations in mind let us turn to co-operative researches in Medicine and Dentistry.

MEDICINE

I. *Orthopaedics.*

1. The evolutionary aspect of postural adaptation.
 - a. Method: comparative primatology; human paleontology; experimental kinesthiology. (Elftman et al.)
 - b. In the skeleton: vertebral column; pelvis; leg and foot; balancing of the head. (Schultz; Thieme)
 - c. In muscles, vessels, viscera. (Gregory; Washburn)
 - d. The age-timing of vertebral pathology. (Todd; Stewart)
2. The ontogeny of posture.
 - a. Age-changes. (Earle Reynolds)
 - b. Typical vertebral curves (Edward Reynolds and Hooton); racial differences.
3. Growth studies.
 - a. Bone growth; long bone growth measured roentgenographically (directly and via "scars of arrested growth"). (Todd; Frances; Sicher; Maresh; Lanier)
 - b. Bone development, with special reference to traumata.
 - (1) ossification centers
 - (2) epiphyseal union
 - (3) bone density. (Mack)
 - c. Age-changes in tissue-muscle-bone relationships. (Stewart; Earle Reynolds)
 - d. The effects of skeletal growth and development of surgical fusions (vertebral) and ankyloses (limb).
4. Prosthetic studies. (McCown)
 - a. The determination of norms of limb size, proportions, and shape.
 - b. The effect of extent and post-operative duration of limb amputation on the supporting girdle. (Barber)

- c. Changes in the stump after operation and in connection with the pressures of functional prosthetic devices.
5. The "stress-coat" studies of tensile strength of bone. (Evans et al.)

II. *Pediatrics.*

1. Growth studies: aims

- a. H-W-age tables and graphs. (Wetzel; Pryor; Gray; Bayley; Stuart and Meredith)
- b. Norms of size and proportion; sex differences in external morphology. (Todd, Krogman; Earle Reynolds; Greulich)
- c. Norms of time and rate of growth in systems and regions of the body. (Scammon)
- d. Norms of maturation
 - (1) skeletal. (Todd et al.)
 - (2) pubertal (biochemical and physiological). (Greulich et al.)
- e. The establishment of statistical validation of the foregoing to establish range of variability.

2. Growth studies: technics

- a. Mensurational: landmarks and dimensions. (Krogman et al.)
- b. Maturational: roentgenographic and endocrinic. (Garn)

3. Growth studies: application

- a. The assessment of deviant growth
 - (1) amount
 - (2) timing
- b. The prognosis of therapeutic recovery.

4. Growth studies: conditioning factors

- a. Health and diet; experimental and control-observational
- b. Socio-economic level; ethnic and family-line (genetic) background. (H. Evans; Asling)
- c. The effect of endocrine and neuro-humeral control (Penfield)
- d. The role of atomic radiation (Greulich)

III. *Dermatology.*

1. The range of variation of human (racial) pigmentation (Todd; Blackwood; Bowman; Edwards and Duntley)
 - a. The racial response of skin to ultra-violet radiation (Clements)
 - b. The genetics of the sacral pigment spot and of pigmentation generally.
2. The hair: age-changes in color and in amount (especially head-hair). (Danforth; Trotter, Garn)
 - a. Form and texture of head hair
 - b. Patterns of body hair distribution.
3. The comparative anatomy of the pilous system.
4. Dermatoglyphics. (Cummins, Midlo, M. Newman)

IV. *Ophthalmology.*

1. The growth of the eyeball (Todd)
2. Eye-ball and orbit
 - a. Growth relationships (Washburn)
 - b. Axis and dimensions of optic nerve (Keyes)
3. Comparative morphology of the eye-ball, with special reference to the Primates
 - a. Pigmentation layers
 - b. Iridial patterns
4. Inheritance of eye color (Brues)

V. *Obstetrics.*

1. The problem of sex differences in the pelvis (Washburn et al.)
2. Growth-changes in the pelvic bones (Todd; Greulich; Earle Reynolds)
3. The classification of female pelvic types (Caldwell and Moloy; Greulich and Thoms)
4. Pelvimetry (Campbell and Rubinstein; Greulich)
5. Problems in gynandromorphy and difficulty of pregnancy

VI. *General Medicine.*

1. "Constitutional medicine" (Angel; Draper; Garn; Sheldon)
 - a. Body-build and disease susceptibility
 - b. Body-build and psychoses (Sheldon)

- c. Morphological differences in disease and psychotic patterns
 - (1) external form (Dupertuis)
 - (2) internal (visceral) form
- 2. Medical history
 - a. The antiquity of disease (human paleontology) (Krogman; Stewart)
 - b. The antiquity of the healing art (archaeology)
 - c. The geography of disease (Hamlin)
 - d. "Medicine" in preliterate peoples
 - (1) the medicine man
 - (2) native pharmacopeias
 - (3) the concepts of medical treatment
- 3. Gerontology
 - a. The changing population (Howells)
 - (1) numbers, per se
 - (2) change in age-groupings
 - b. The registry of old age (Todd et al.)
 - (1) in the skeleton
 - (2) in the tissues of the body (muscles, vessels, viscera, especially)

VII. *Medico-legal research.*

- 1. Identification of skeletal remains (Krogman, Stewart, M. Newman)
 - a. Age, sex, race
 - b. Stature, build, duration of interment, etc.
- 2. Physiognomic restoration (Krogman)
- 3. The integration of these researches into broader fields
 - a. Military: Grave Relocation Service (Shapiro, Snow, Trotter)
 - b. Civilian: disaster situations involving mass deaths (e.g., plane crashes, A-bomb destruction).

VIII. *Aero-Medical Research: Quartermaster Corps.*²

- 1. The constitution factor in performance
 - a. Classification of body-build (Sheldon)
 - b. Relation of body-build to performance
 - (1) pilot achievement (Damon)

²Numbers VIII and IX are not strictly "medical," yet they represent contributions to human well-being that come within a broad interpretation of "health."

- (2) size-factor in pilots (Sheldon, Hooton, Dupertuis)
 - (3) physiological factors (Seltzer, Brouha, Gallagher)
 - 2. Studies in material production and sizing. (Q.M.C.)
 - a. Clothing tariffs (Randall, White, R. Newman, Leche et al.)
 - b. Equipment factors in planes, tanks, etc. (Randall, Benton, Brues; Hertzberg and colleagues)
 - 3. Psychosomatic factors in aptitude and achievement
 - a. In flight training (Harvard group)
 - b. In highway-driving (McFarland)
- IX. *Applied Physical Anthropology* (other than in VIII).
- 1. Seating problems in public vehicles (Hooton)
 - 2. Seating designs for growing school children (Krogman); seat-desk relationships (Harmon)
 - 3. The field of "human engineering" in broader aspect
 - 4. a. Seating and work-table studies in industry
 - b. Time-motion studies in industry involving size and build factors in manual skills.

DENTISTRY

I. *Orthodontics and Prosthetics.*

- 1. Growth studies (Brodie, Broadbent, Garn, Hughes, Krogman et al.)
 - a. Calcification and eruption of the teeth (Massler and Schour, Broadbent, Hurme)
 - b. Growth and development of head and face
 - c. The analysis of time, rate, and locus in facio-dental development
 - d. The phylogenetic and comparative aspects of dento-facial growth (Todd and colleagues)
 - e. The experimental approach to the problem (Washburn and colleagues)
- 2. Changes in the facio-palatal relationships in tooth-loss
 - a. Studies on alveolar change
 - b. Analysis of functional stresses under conditions of prosthetic therapy

3. The analysis of dental variability
 - a. Race differences in tooth form and size, eruptive time and sequence, and so on.
 - b. Racial incidence of dental disease.

II. *Oral Surgery.*

1. The analysis of the morphology of cleft-palate and cleft-lip
2. The study of the (deviant?) growth pattern in such cases
 - a. The degree of interference in inter-dental relationships
 - b. The problem of "timing" in surgical repair (Brodie and Slaughter, Krogman) with reference to the child's growth potential (Thompson and Brader)
3. The relationship of palato-oral development to nasopharynx and to oral pharynx with reference to tonsillar and adenoidal masses (Rosenberger)

III. *Children's Dentistry.*

1. The general theme of the integration between dental development, bodily growth, and maturation (Forsyth group)
2. The analysis of the growth effects of premature or extremely late exfoliation of the deciduous dentition.

GENETICS

The contributions of human genetics to medical and dental problems cannot be over-estimated. There are many and useful pedigrees of pathological traits, in bone, in teeth, in muscles, in physio-biochemical functions, in the neural mechanism, and so on. These data are extremely useful in outlining a broader perspective against which we may limn the specific problems that have been indicated above.

Present work suggests, for example, that a child's size, body-build and growth-pattern may follow a family-line biogenetic endowment. We have reason to believe that malocclusion has a genetic basis; the genetic evidence for cleft-

palate and cleft-lip is even more convincing. These are but a few examples that come to mind.

Certain it is that physical anthropologist and human geneticists are — or should be — complementary members of a team focussing upon human biology in all its possible medico-dental ramifications.

GOAL

This outline is designed to make physical anthropologists think dynamically in terms of living, functional problems. It is designed, too, to let dentists and doctors know:

- | | |
|-------------------------------------|-------------------------------|
| (1) that we <i>are</i> so thinking; | } that we may think together! |
| (2) <i>what</i> we're thinking; | |
| (3) <i>how</i> we're thinking. | |



FRANZ-WEIDENREICH-INSTITUT FÜR ANTHROPOLOGIE.—The Anthropological Institute of the Universität Frankfurt am Main was re-established with the beginning of the summer semester of 1950. The Institute, for physical anthropology, founded by Dr. Franz Weidenreich in 1928, was dissolved by the Nazi regime during Dr. Weidenreich's tenure as Honorary Director of the Cenozoic Research Laboratory of the Geological Survey of China. The reestablishment of the Institute under the name of its founder, to whom anthropology is in such great debt, is meant to stand as a monument honoring the memory of this great research worker and at the same time to emphasize the tradition, identified with Franz Weidenreich, of rigorous scientific research and teaching. The pleasure over the reopening of the research center, created by Weidenreich, is mingled with sorrow that that greatly deserving scholar could not have lived to see this tardy tribute.

This announcement is sent by Priv. Doz. Dr. P. Kramp, who is in charge of the Institute.

REVIEW

GENETICS AND THE RACES OF MAN. AN INTRODUCTION TO MODERN PHYSICAL ANTHROPOLOGY. By William C. Boyd. xvii + 453 pages, 52 illustrations. D. C. Heath & Co., Boston. 1950. \$4.50.

Professor Boyd has written an important book, the first published work dedicated to the task of transfusing the core ideas of the new systematics into the near supine body of racial anthropology. He has admirably succeeded in this major aim, and the few flaws present are on a minor scale. The author clearly states the limits within which he has chosen to write, a consideration of the genetic approach to physical anthropology. He does not imply that other points of view do not have their own value. Since Boyd has set out to summarize the new point of view toward racial anthropology, his enthusiastic pursuit of this purpose has understandably led him to undervalue the contributions of comparative morphology to our understanding of human evolution during the Pleistocene. The methods and contributions of comparative anatomy to the study of evolution have been discerningly analyzed by Zangerl (*Evolution*, vol. 2, no. 4, 1948), and his ideas could profitably have been included in the present work. Boyd, however, entered physical anthropology as a serologist, rather than a morphologist, and this omission should not be allowed to minimize the valuable contributions of "Genetics and the Races of Man."

The first three chapters comprise a background of ideas and materials. Possible approaches to a study of man are explored, and Boyd cheerfully exhumes some of the earlier conceptual scandals in physical anthropology. Professional readers will note a few dead horses among the disinterments, but the general critical tenor is wholesome and indicates an awareness of the pitfalls into which anthropologists have stumbled in the too recent past. Here, and in later chapters, the author underlines the true meaning of genetic linkage, the limited evolutionary implications of inbreeding, the fallacy of the concept of a "pure race," the error in the idea that a dominant allelomorph will spread through a population simply because of its dominance, and the impossibility of using the typological approach to reconstruct the basic components which have contributed to an old, mixed population. He reacts strongly against the overemphasis which in the past has caused physical anthropologists to

expend an undue proportion of their research energies in the measurement and metrical analysis of osteological series. It is suggested that those who would disagree with his position should carefully reread the paraphrasing of R. A. Fischer's trenchant evaluation of craniometry (p. 25).

Basic mendelian genetics are summarized in 51 pages of compact and lucid writing. The treatment goes far beyond Mendel's original laws and covers such important topics as the stability of genes, the mechanism of gene action, physiological effects of genes, the similar effects of different genes, and genetic linkage. There follows a chapter on heredity and environment which is modern in treatment. The concepts of population genetics are concisely surveyed in the three subsequent chapters. The subject is approached through a discussion of gene equilibrium without evolution. There follows a consideration of those factors which do modify gene frequencies. These 4 basic forces, hybridization, mutation, selection and random genetic drift, acting singly, or as is more likely, conjointly, provide an understanding of the processes of evolution. The influence of geography on racial distributions is also considered. Throughout these sections, as is stressed by the author, there is paucity of human data to illustrate the theoretical concepts which have been established by the other natural sciences. This lack, which so contrasts with the massive data of descriptive nature for man, can only be blamed upon the tardy appreciation for the new systematics which physical anthropologists, as a group, have shown.

It must be admitted that today the theoretical bases of genetical anthropology are better developed than are its applications to concrete data. Boyd does well with the limited materials available. After evaluating the older definition of race, and exploring its implications, he presents his own:

"We may define a human race as a population which differs significantly from other human populations in regard to the frequency of one or some of the genes it possesses. It is an arbitrary matter which, and how many, gene loci we choose to consider as a significant 'constellation'; but it seems better, on the one hand, not to designate a multiplicity of races which differ only in regard to a single pair or a single set of allelic genes; and on the other, not to insist that all the races we define must differ from each other with respect to all their genes." (p. 207)

Thus, as with the older anthropological definition, the genetical definition of race may be applied at various levels of difference between populations. The resultant flexibility carries a disadvantage in containing a taxonomic subjectivity, but this danger is to be preferred to a premature introduction of formal rigidities into the concept.

The following section, on the blood groups, presents the author in his special field of competence. The O-A-B blood groups, the M-N blood types and the Rh factors are presented in compact but thorough fashion. Those readers who may have struggled with the conflicting terminologies and the confusing literature on the Rh series of genes will here be rewarded with a concise discussion of the situation at its current stage of development. Table 29 tabulates the frequencies of the Rh phenotypes for 36 populations tested at the time the manuscript was completed. Huxley's concept of the cline, which was introduced earlier, is illustrated by isogenic maps of the world for the blood group gene A and the gene B.

Boyd next utilizes the blood groups for purposes of human classification. He commences with an illustrative analogy intended to show that the serological alleles at three loci, were they expressed as visible phenotypic traits, might in terms of their varying frequencies in the different populations of the world produce a series of imaginary races not unlike those existing in reality. He obviously feels a sentimental attachment to this fanciful device, but 8 pages seem too much to have been expended upon it. On a more fruitful plane, he tentatively identifies 6 genetically different races by utilizing the variable frequency of alleles at three serologically defined loci, the secretor alleles and the PTC frequencies. The racial groups so defined consist of Caucasoid, Negroid, Mongoloid, American Indian, Australoid and a 6th purely hypothetical group, Early European. This classification differs but slightly from that formulated by Wiener, which was also based upon gene frequencies. These 6 racial categories, omitting the inevitable intermediates, correspond well with geographical factors. Although no phenotypic characters have been utilized, it is interesting to note that these categories do little violence to the major racial groups usually agreed upon by non-genetical anthropologists. The division of the Mongoloids into an Asiatic and an American race has not always been deemed necessary upon a morphological basis, but in terms of the number of genetic loci tested to this point, the division seems justified. The hypothetical Early European group has been created to include the Basques, who deviate rather markedly from other Europeans in gene frequencies. Its existence is dependent upon the interpretation that the Basques represent a survival into modern times of an earlier type which has remained sheltered in a mountainous marginal area. In evaluating this racial schema of Boyd's, two points should be remembered: first, classical anthropologists working over many decades upon vast bodies of descriptive data have done little better in identifying the major racial populations of the world; secondly, the genetical approach to racial analysis of living human populations offers the unique advantage of operating in terms

of the units which are basic in evolution, units which alone can lead to an evaluation of evolutionary processes. Rather than to produce dissension, these slender genetical beginnings should suffice to let us hope that profitable fusion should soon occur between the conceptual framework of a genetical racial anthropology and the salvageable data of the older classical approach. Boyd is aware that the analysis of race may profitably include other variables than the serological genes. Two chapters are devoted to the discussion of other human genes, and to incompletely analyzed genetic characteristics. The reviewer wholeheartedly agrees that for the present it would be wise to utilize morphological traits in addition to the limited available number of genetically analyzed characteristics.

An historical reconstruction of man's past, largely in terms of the A-O-B blood groups, is presented. This exercise illustrates the dangers inherent in any effort to unravel the complex story of the evolution of man in terms of too few variables. Boyd's theoretical position is sound, but his enthusiasm has led him to run beyond the validity of the still-seanty genetical data pertinent for the analysis of the earlier phases of human evolution. As Simpson has demonstrated for paleontology, a synthesis of modern genetical thinking with the older morphological and metrical approaches could raise the study of human evolution in the Pleistocene to new levels of significance. Here the issue is not one of genetical anthropology or classical anthropology alone, but quite clearly one of judicious fusion.

One of the most important contributions of this book lies in a system of appendices. Appendix A, "Statistical Methods," compresses into 39 clearly written pages the bases of those probability statistics which are useful in modern physical anthropology. It concludes with the chi-square test, the calculation of gene frequencies, and a discussion of the method for testing a genetical linkage. Eleven other short appendices follow, each keyed into the chapter to which it refers. These serve to provide a more detailed mathematical explanation and elaboration of points raised in the text. This organizational procedure has a number of virtues: it does not impede the reading of text material with mathematical complexities; it provides for the student interested in obtaining a real insight into the genetical approach to anthropology, both the mathematical tools used in the detailed analysis and a comprehension of the limiting mathematical assumptions upon which they are based. The serious reader will find these appendices an invaluable addition to the volume.

Professor Boyd has provided anthropologists with a critically needed volume which synthesizes a modern genetical approach for the analysis of living races. It is a work of great virtue and should be read by all anthropologists, professional and students alike. Its

minor flaws result from the author's enthusiastic but presently premature conviction that a genetical approach can answer all of today's questions concerning human evolution. The organization of the book is to be commended for its flexibility. The arrangement of the more technical aspects in the appendices allows it to be used as a text for teaching in those courses oriented toward a genetical approach to racial differentiation. As a measure of the upper end of its scale of potentialities, let it be said that there are few professional anthropologists, whether they be physical or cultural, who would not benefit in some fashion from an intensive study of the total volume. Professor Boyd is to be commended for this contribution to physical anthropology, and one may expect that the profession will voice its appreciation.

JOSEPH B. BIRDSSELL
University of California
at Los Angeles



LIMITATIONS OF HEIGHT-AGE-WEIGHT TABLES.—In the course of studies on ageing, carried out since 1947 at the Laboratory of Physiological Hygiene, with special emphasis on the cardiovascular system and its disturbances, we became acutely aware of the misleading nature of the height-age-weight standards. In terms of quantitative morphology a middle-aged man, retaining his relative position in the distribution of weight for men of a given height, differs markedly from his physical status in his early twenties.

The concept of "normal" body weight, defined actuarially, tends to obscure the profound changes taking place in the process of ageing. The latter involves not only an additive accumulation of body fat but also, very likely, replacement of some of the muscle (and other "active tissues") by fatty tissues.

... In view of the variations in the composition of the body at the same weight and the differences in the metabolic properties of muscles and the depot fat, it appears that the expression "per kg of body weight" may lead to erroneous conclusions.—Josef Brožek and Ancel Keys. Limitations of the "normal" body weight as a criterion of normality. *Science*, n.s. vol. 112, no 2922 for December 29, 1950, p. 788.

LUIS DE HOYOS SÁINZ, who celebrated his 80th birthday June 21, 1948, was honored on this occasion by his colleagues with a volume "Homenaje a Don Luis de Hoyos Sáinz (Gráficas Valera, S. A., Madrid, 1949, 358 pp.). The wide interests of Dr. Hoyos, which extended to physical anthropology, ethnology, biology, physiology, demography, folklore, human geography and agriculture, are shown not only by his bibliography and a list of the doctoral theses written under his direction but by the contents of the volume. Among the contributions, the following are of interest to physical anthropology:

	page
Curriculum vitae	15
Bibliografía de las publicaciones científicas de don Luis de Hoyos Sáinz	19
Eugen Fischer: Problemas antropológicos de las Islas Canarias	153
Wilhelm Gieseler: Ueber die epipaläolithischen Kopfbestattungen aus Süddeutschland	173
J. Imbelloni: Reapertura y modernización de una discusión secular sobre los dolicocefalos del Perú antiguo	183
A. Mendes Correa: La posición sistemática de los Amerindios	217
G. M. Morant: Changes in the size of British people in the past hundred years	235
Eugene Pittard: A propos de l'augmentation de la taille humaine actuellement observée	265
O. Reche: Die modernen Fortschritte der Blutgruppenforschung und die praktische Verwendung der Ergebnisse	273
Otto Schlaginhaufen: Neue Funde menschlicher Skelette aus der Bronzezeit der Schweiz	285
G. L. Sera: Il valore morfologico funzionale, filético del femore del cosiddetto "Bradytherium"	301
E. Tamagnini: O índice nasal e o clima	311
J. C. Trevor: The metrical features of Ashanti and others. African Negro crania	317
H. V. Vallois: Paléopathologie et paléontologie humaine	332

PRESENT INTERPRETATION OF TAURODONTISM.—The old hypothesis, that the fossil hominids possessing taurodontism could not represent a stage in the phylogeny of *Homo sapiens*, was based on the assumptions that taurodontism did not occur in the anthropoid apes and in modern man. But we now know that both of these suppositions are wrong.

On the other hand, the evidence we possess indicates that *Homo sapiens* is derived from a moderately taurodont ancestor and that during the course of evolution of the species the size of the pulp chambers has been reduced. But it is evident that this process of reduction has not proceeded at an equal pace in all the races, as some still preserve, or have at least till recently preserved, traces of a moderate degree of taurodontism.—Muzaffer Süleyman Senyürek. The occurrence of taurodontism in the ancient inhabitants of Anatolia. *Belleten (Türk Tarih Kurumu, Ankara)*, vol. 13, no. 50, April, 1949, pp. 215–227 (in Turkish and English).

PROCEEDINGS
OF THE TWENTIETH ANNUAL MEETING
OF
THE AMERICAN ASSOCIATION OF
PHYSICAL ANTHROPOLOGISTS

The twentieth annual meeting of the American Association of Physical Anthropologists was held on March 19, 20 and 21, 1951, at the University of Michigan, Ann Arbor, Michigan. Fifty-nine persons were registered, including 47 members. The Association was cordially welcomed by Dean Hayward Keniston of the College of Literature, Science and the Arts, at a luncheon given on Monday by the University of Michigan. Fifty-three persons attended the annual dinner Tuesday evening which was addressed by Professor Wilton M. Krogman on "The Role of Physical Anthropology in Dental and Medical Research." Before Dr. Krogman's talk Professor W. W. Howells showed some colored slides of human fossil remains. On the evening of March 19 the members and friends of the Association were entertained at an informal smoker in the home of Professor James B. Griffin.

BUSINESS MEETING, MARCH 20, 1951

The minutes of the nineteenth annual meeting, as printed in the Proceedings, were voted approved.

The secretary reported that since the founding of the Association there has been a constant and accelerating increase in membership.

1930	109	1942	153
1935	113	1946	183
1938	130	1950	219

Since the inception of the Association there have been only five secretaries, but neither of the last two have finished a

term of five years and the incumbent also thought that in the absence of compelling reasons to the contrary and in view of the availability of very competent candidates for the office, the Executive Committee should seek a suitable successor. The Executive Committee proposed Dr. Earle L. Reynolds for Secretary-Treasurer, and he was unanimously elected.

The Executive Committee presented the following candidates to the Association. All candidates were unanimously elected to membership.

Richard Ashman	Robert E. Hanna
Frances Baer	E. A. Hoebel
George B. Barbour	D. A. Hooijer
Charles L. Camp	Paul Leser
Michael Charney	Coenraad F. A. Moorrees
John A. Cosentino	Yolanda Murphy
L. S. Cressman	Esko Kalervo Näätänen
Gilbert Daniels	Jane Raven Orttung
Anthony F. DePalma	Richard Osborne
Th. Dobzhansky	Carroll L. Riley
E. Lloyd DuBrul	Maurice B. Roche
Marie Fetzer	J. B. Scott
John Gillin	J. H. Sillman
Otto E. Guttentag	H. M. Wormington

The Treasurer's report and the report of the Auditing Committee, as follows, were read and accepted.

TREASURER'S REPORT

Prudence Bond	\$ 100.00
U. S. Savings Bonds, maturity value	3,000.00
	<hr/>
	\$3,100.00
<hr/>	
Bank balances, March 15, 1950	\$2,684.24
Receipts	
Dues	\$1,282.00
Sale of STUDIES IN PHYSICAL ANTHROPOLOGY	63.96
Interest on savings account	16.06
	<hr/>
	1,362.02
	<hr/>
	\$4,046.26

Expenditures

To Wistar Institute (for subscriptions) . . .	\$1,506.50
To Wistar Institute (for Proceedings)	46.63
To Bertram Kraus (for 1951 P. A. Newsletter)	50.00
To S. M. Garn (for guests at annual dinner)	12.12
To Bolar Printing Co. (for programs)	13.58
Secretarial expenses	110.21
Bank charges, checking account	6.24
	<hr/>
	\$1,745.28

Bank balances, March 15, 1951

Savings account	\$1,719.11
Checking account	581.87
	<hr/>
	2,300.98

\$4,046.26

March 15, 1951
Respectfully submitted,
GABRIEL LASKER, Treasurer

Certified to be as stated above.

March 20, 1951
MYRL MILES
EDWARD E. HUNT, JR.
Auditing committee

The Treasurer recommended that the Secretary's budget for secretarial expenses be raised to \$200.00 (including not more than \$50.00 to cover the Secretary's expenses at the annual meeting of the Association). It was pointed out that the annual dues have not been increased since the inception of the Association except for the inclusion of the subscription to the Journal, and no change was recommended. The slight increase in the new Secretary's budget necessary to cover new stationery, etc., can be met from current income. The budget was voted approved.

The Editor, Dr. W. W. Howells, presented the following report:

REPORT OF THE EDITOR

The Editor would like to express his gratitude to Dr. Stewart, who very kindly managed the affairs of the Journal for three months during the summer while the Editor was abroad.

Volume 8 of the Journal contained 526 pages, consisting of 29 articles and brief communications, and 21 reviews of books and monographs. During the year, 12 articles were returned unaccepted because of unsuitability to the Journal. Of 29 authors concerned in the production of original articles published, 15, or slightly over half, were members of the Association; this is a better proportion than the year before, but a smaller absolute number of Association authors.

The Editor's report was accepted.

No report was presented by the Editor of the P. A. Newsletter, who could not be present this year, but the Secretary explained that the delay in the appearance of the Newsletter this year was through no fault of Dr. Kraus. An appropriation of \$50.00 for the Editor of the Newsletter for next year was voted.

President Stewart reported that, at the urgent request of Dr. Metraux of UNESCO, he had appointed Dr. H. L. Shapiro to represent the Association on a new UNESCO panel of experts which is to revise the Statement on Race. Dr. Stewart made it clear that this appointment did not automatically commit the Association to approval of the new statement. With this stipulation explicitly included, the Association voted to confirm the appointment.

The Nominating Committee (George Neumann, Robert White and James N. Spuhler, chairman) reported that they had received 60 nomination cards from the membership and that their function had been merely to tally the suggestions and to present the names of the three leading nominees for each office in alphabetical order.

For President:

McCown

H. L. Shapiro

Washburn

For Executive Committee:

Montagu

Snow

Trotter

Drs. Washburn and Snow were elected.

In the absence of Dr. Montagu, Dr. Eiseley reported for the Viking Fund Award Committee. Dr. Krogman had been

awarded the medal and prize at a dinner in New York in February. It was noted that in addition to the numerous accomplishments mentioned in the citation, Dr. Krogman was president of the Association for two terms and saw the Association safely through the difficulties of some of the war and post-war years. The report was accepted.

Dr. Howells, the president of the American Anthropological Association, was invited to report concerning action by that Association on the question of academic freedom and tenure at the University of California. Dr. Howells read the following resolution which had been passed by the Council of Fellows of the American Anthropological Association:

A RESOLUTION CONDEMNING THE ACTION OF THE REGENTS OF THE
UNIVERSITY OF CALIFORNIA IN VIOLATION OF THE RIGHTS OF
ACADEMIC FREEDOM AND TENURE

The Regents of the University of California, by the vote of a bare majority of its members, have imposed upon the faculty of the University of California a contract incorporating in substance a special test oath not required of other public servants of the State.

All members of the faculty of the University of California have traditionally, in the manner expected of public servants, affirmed their loyalty to the State and federal constitutions.

The imposition of special test oaths, either directly or indirectly, is discriminatory and contrary to well-founded principles of the American democratic tradition. It serves to introduce into a community of teachers, scholars and scientists an atmosphere of crass intimidation and insecurity incompatible with the democratic spirit of free inquiry essential to the growth of knowledge and the nourishment of our free society. Further, such test oaths are ineffective and actually protect subversive elements who will not hesitate to sign such test oaths.

The Regents of the University of California have arbitrarily dismissed members of the faculty solely because, in their dedication to high ideals of democratic rights and academic freedom, they felt they could not in conscience accept the discriminatory contract imposed upon the faculty by the Regents. By this action the Regents have harshly abrogated the rights of tenure to which faculty members are traditionally entitled.

Therefore be it resolved: That the Council of Fellows of the American Anthropological Association condemns the action of the Regents of the University of California as an arbitrary act of injustice destructive of the morale of scholarship and inimical to the interests of American society.

And further, that all members of the American Anthropological Association be urged to oppose such test oaths in all universities and to assist in every practicable way to find suitable positions for qualified persons who have suffered dismissal in

consequence of their refusal to subscribe to the discriminatory contract; and that each member be urged to respond as generously as possible to appeals for financial assistance on behalf of the dismissed members of the University of California faculty.

By this action the American Anthropological Association supports the stand of the Governor of the State, the President of the University, the minority of the Regents, and the University faculty in support of established tenure and freedom of thought, and expresses its faith in the ultimate right solution of this controversy and in the future of the University of California as one of the world's great institutions of learning.

The secretary is instructed to send copies of this resolution to the appropriate members of the faculty, to the President of the University, the Regents, and the Governor of the State.

Berkeley, California

28 December, 1950

Dr. Howells noted that some 20 national learned societies had taken similar action. He recommended that the American Association of Physical Anthropologists adopt this resolution or a similar one. Dr. Angel, speaking for the Executive Committee, moved:

Resolved that the American Association of Physical Anthropologists adopts the resolution of the American Anthropological Association condemning the action of the Regents of the University of California in violation of the rights of academic freedom and tenure.

It was unanimously approved.

The Secretary read a letter from Dr. Arne Björk stating that he had held a conversation with Professor H. Hjortsjö of the University of Lund concerning the formation of a Swedish Association of Physical Anthropologists, and that they would welcome information concerning the ideas on which our Association is based. The Secretary was instructed to explain the history of our Association and to lend our encouragement.

Dr. Washburn suggested that members correspond with persons publishing in the field of physical anthropology with the purpose of interesting them in the Association. Dr. Howells pointed out that a steady increase in the membership would strengthen the Journal greatly. It was pointed out that the membership requirements do permit the election to membership of scholars primarily interested in investigation in cognate fields rather than in physical anthropology itself,

and that graduate students in anthropology are not to be excluded merely for not having achieved the Ph.D. degree. Dr. Lasker added that one of the purposes of the Association, the dissemination of the results of scientific research in physical anthropology, can be furthered by increasing the number of subscribers to the Journal and members of the Association.

Dr. Washburn announced the plans for the Viking Fund Summer Seminar. He indicated that this year he hopes to assemble a group at the Viking Fund in New York during the week of June 25-30. Any members who wished to, would be welcome to attend, but the purpose was somewhat different than it had been at some past sessions and the group would probably be smaller. It was hoped that the seminar this year could attack some of the fundamental issues of physical anthropology with a view to answering the question: "What is physical anthropology?" The results of such a discussion should eventually take the form of a series of articles or a small book, but the first step would be to exchange views and then to circulate these thoughts in the form of a mimeographed letter at the termination of the seminar. The replies would be edited and would form the basis of further mimeographed letters during the year. By the following summer it would be clear who was interested in participating in the 1952 seminar. By then it should be possible to set forth a variety of ideas on this subject, not only any formulation that may be generally agreed upon but also suggested alternatives, modifications, and minority opinions. The previous exchange of bulletins and the informality of the 1951 meetings should assure mature discussion at the 1952 session, worthy of publication.

President Stewart expressed our debt of gratitude to the Viking Fund for having made the summer meetings possible and to Dr. Washburn for his able direction of the program. It was noted with pleasure that the name of the Viking Fund is to be changed to "Wenner-Gren Foundation for Anthropological Research" to include the name of the founder and to specify the field of interest.

Dr. Eiseley moved that the President be instructed to communicate to Dr. Schultz our feeling of loss in his leaving the United States and to extend to him the best wishes of the Association for his success and happiness in his new position. The communication should express our feelings of attachment to Dr. Schultz, one of our founders and a past president, who had been one of the most faithful members, coming to our meetings year after year. The motion was unanimously approved.

The following report was submitted by the Resolutions Committee:

I. Be it resolved that the Association hereby expresses its gratitude and appreciation to the University of Michigan for its generous hospitality during the 1951 meetings, and to the Department of Anthropology, the Museum of Anthropology, the Horace H. Rackham School of Graduate Studies and the Institute of Human Biology of the University and all of the staff members and others who participated in the arrangements of these meetings.

It is particularly fitting that the twenty-first anniversary of the founding of this Association should be held in the halls of a great university which recognizes the significance of physical anthropology.

A comparison of the program of the 1951 meetings with that of the first meetings at Charlottesville demonstrates the progress which has been achieved in American physical anthropology both quantitatively and conceptually at its coming of age.

II. Be it further resolved that the Association expresses its appreciation to the Wayne University College of Medicine for its generosity in placing the facilities of the college at the disposal of the Secretary of the Association during the last four years.

III. Be it resolved also that the Association expresses its appreciation to the Viking Fund for the continuing support it has given to the Profession both through its publications, through the Summer Seminar, through Fellowships and through the support it has given to the research of individual scientists.

IV. Be it resolved also that the Association expresses its deep appreciation for the hospitality of Professor James B. Griffin who so graciously entertained the members at his home.

V. Be it finally resolved that these resolutions be incorporated in the minutes of these meetings and be published in the Proceedings of this Association.

Respectfully submitted,

GORDON T. BOWLES

WILLIAM L. STRAUS, JR.

The resolutions were adopted unanimously.

Dr. Eiseley moved a rising vote of appreciation to the retiring secretary, Dr. Lasker, for his work on behalf of the Association. The members rose and the meeting adjourned.

Dr. Krogman having been unable to attend the business meeting, presented on March 21, the report of the Committee on Representation in the National Research Council. He stated that the committee had sent a statement announcing its existence to various governmental agencies and others who might wish to consult them. Among other results of this letter was the establishment of a fruitful relationship with those responsible for aeromedical research.

Another request made of the committee was in connection with Selective Service deferment policies. As there was need for immediate response, a special subcommittee consisting of Drs. M. T. Newman, Lasker and Krogman (chairman) began preparation of preliminary answers to the questions: What are physical anthropologists? What immediate and what long run contributions can physical anthropologists make: (1) to the military establishment, (2) to the civilian economy? The subcommittee is interested in collating opinions of other members on these subjects and Dr. Krogman has received suggestions from numerous individuals. The subcommittee wishes to stress two major points: (1) It would be a mistake to divert teachers and students from physical anthropology to non-related tasks. (2) No dichotomy should be drawn between applied physical anthropology and the basic contributions of the discipline.

The scientific part of the program consisted of the following papers:

1. *Sex differences in the Eskimo pelvis.* Robert E. Hanna, Department of Anthropology, University of Chicago.

Three techniques were used on an osteological series of Eskimo pelvises to determine the sex. The techniques used were the ischium-pubis index, an improved method on the estimation of the angle of the sciatic notch and the interiliac index.

Correlations between the indices, corroborated with other anatomical knowledge, showed that each index was estimating a different sexual characteristic. Therefore, each index may independently determine the sex of a pelvis within a designated range. When a pelvis fell in the doubtful range of one method, the other two could be utilized to determine the sex. By using the three methods, the sex of all of the pelvises could be determined.

2. *Structure of the Neanderthal face.* F. Clark Howell, Department of Anthropology, University of Chicago.

Differences were noted in the morphology of the facial skeleton of the early Third Interglacial Neanderthals (Mount Carmel, Saccopastore, Steinheim) and the later Fourth Glacial classic Neanderthals (La Chapelle, La Ferrassie, Monte Circeo, et al.). These are: (1) The tendency for separation of medial and lateral supraorbital elements in the early Neanderthals; fusion of these two elements into a continuous torus in the classic specimens. (2) A tendency for formation of an incipient canine fossa, with demarcation between malar and maxillary bones, the malar being directed latero-anteriorly, in the early Neanderthals; the classic Neanderthals have maxillary bones shelving posteriorly into the malars, no sharply defined inferior malar margin, and a full or flat area in the usual region of the canine fossa.

Preservation of the mandibles of several fossils suggests that these distinctions may have been associated with differences in the masticatory musculature. Thus, more acute mandibular angles in some early Neanderthals indicate larger areas for masseter insertion than in the classic Neanderthals in which the angles are more oblique. Heavier masseter muscle mass in the early Neanderthals would account for the laterally and anteriorly directed malar and the heavier lateral supraorbital element oriented anteriorly and more distinct from the frontal squama than is the case in the classic Neanderthals. Several facial characters, often regarded as morphological isolates, may thus be related to the development of the masseter muscle.

(This is part of a larger study of Neanderthal cranial morphology supported by a grant from the Viking Fund.)

3. *Analysis of the zygomatic region by split-line technique.* Neil Campbell Tappen, Department of Anthropology, University of Chicago.

The zygomatic region is analyzed by Benninghof technique and the deep dissection refinement of this technique introduced by Seipel. Results of both tests

indicate the same conclusions. The so-called "zygomatic pillar" is not a functioning structural unit but must be analyzed into different parts. Trajectories in the maxillary portion of this "pillar" ascending from the alveolar region are completely interrupted by trajectories paralleling the inferior border of the orbit and continuing to the region of origin of masseter tendon. This continuity of trajectories indicates that the region of the infraorbital margin is neither a "buttress" nor a simple binding between pillars, but a functioning unit associated with resistance to tension from the masseter muscle. The region lateral to the orbits above the zygomatic region thus probably has no functional connection with the supra-alveolar portion of the pillar. Its trajectories probably indicate tension from the pull of the masseter muscle rather than pressure, as has been previously supposed. This indicates that the lateral supraorbital region is part of a functioning system under tension from relatively greater pull of masseters and temporals, along with the infraorbital and zygomatic regions. Trajectories of the zygomatic arch are probably in response to tension from the pull of the non-tendinous portion of the masseter muscle.

4. *Growth of the face as shown by intra-vital staining with Alizarin Red "S."*
Melvyn J. Baer, Merrill Palmer School, Detroit, Michigan.

The growth of the skull of the rat was studied by the technique of vital staining with Alizarin Red "S." Examination of the skulls indicates that the zygomatic arches and certain aspects of the mandible (angle of the mandible, mandibular condyle, margins of the coronoid process and masseteric ridge) contain sites of active growth after bone deposition is essentially completed in other areas of the face. Continued growth of the zygomatic arches comprises growth in the transverse diameter while the growth at the posterior border of the mandible represents a longitudinal increment.

It is noted that the zygomatic arches and the mandible form the origin and insertion of the masseter muscle. This raises the problem as to whether the continued growth at these sites (and thus the resultant form of the skull) represents intrinsic growth factors or is dependent, at least in part, on normal muscle function. Since the masseter muscle in the rat plays such a prominent part, it is conceivable that the bone-muscle relationship might be clarified by performing masseterectomies on some form in which the masseter muscle is not as extensive. It is suggested that this type of surgical interference with normal function coupled with the use of the vital-staining technique would provide data on the precise nature of bone-muscle relationships during growth and would pinpoint the specific sites of bone growth. Such an approach would help clarify problems relating to the role of muscle function in determining the form of the skull.

5. *The analysis of anatomical difference.* S. L. Washburn, Department of Anthropology, University of Chicago.

Comparison of adult male monkeys of two different species (Collected in Uganda on a trip sponsored by the Viking Fund) reveals numerous differences in nearly all traditional measurements and observations. But when animals are paired so

that cranial capacity and temporal muscle size are the same, nearly all the apparent differences disappear. It is concluded that the basic difference is in the size of the face (bone, teeth, and muscles) and that almost all of the observed differences between the adults are the results of the primary differences in facial size. The larger-faced species lives in open country and often on the ground, while the small-faced species is strictly arboreal. The large-faced species is paralleling the baboons in both habit and morphology. The differences are clearly of adaptive value.

Interpreting the differences gives a very different picture from a table of measurements and statistical constants. Anthropologists have been content to describe differences and to speculate on their significance. The time has come to develop new techniques in order to interpret and evaluate the nature of differences, whether they are in monkeys, fossil men, races, or constitutional types.

6. *Palaeanthropological problems in Asia.* Dirk Albert Hooijer.

The study of the remains of Early Man confronts us with a number of major problems. However, we have much more material of some other mammals in the Pleistocene faunae of China and Java to which *Gigantopithecus*, *Meganthropus*, *Pithecanthropus* (including *Sinanthropus*), and *Homo* belong. Several genera and species, just as *Homo sapiens*, are still living today in the same area. Of the various theories on the descent of Man, some are supported, others disproved by the study of this associated fauna which, to a certain extent, was molded by the same environmental forces. In Man and the domestic animals the effect of natural selection is modified, and dispersal is no longer completely conditioned by various factors in the natural environment. They interbreed more freely with races not their own. It would seem that more allowance for individual and sexual variation could be made in studies of remains of Early Man, while it should be pointed out that, in modern mammal taxonomy, mere size is not so much a generic as it is a specific or racial differential character. The International Rules of Zoological Nomenclature are seemingly becoming more of a burden than a convenience for most physical anthropologists. In view of all this it is advisable to take into consideration, as far as feasible, what is known about Quaternary evolution of the whole fauna of the area, and especially the techniques employed by modern taxonomists and statisticians while working with fossil and prehistoric human remains.

7. *Comparative "stresscoat" deformation studies on the primate femur.*¹ F. G. Evans, W. L. Straus, Jr., and M. Lebow, Wayne University and Johns Hopkins University.

"Stresscoat" deformation patterns were produced by static vertical loading of femora of adult humans, gorillas, chimpanzees, gibbons, siamangs, langurs, baboons, macaques and Indris. The bones were tested in a materials-testing machine having an accuracy of approximately $\pm 0.5\%$. The average sensitivity of the lacquer used was 0.0009 inches/inch. The range of variation in the loads applied was: *Homo* 450-1280 lbs., *Gorilla* 310-800 lbs., *Pan* 150-350 lbs., *Pongo* 300-550 lbs., *Symphalangus* 90-100 lbs., *Hylobates* 75-100 lbs., *Presbytis* 75 lbs., *Rhesus* 50 lbs.,

Indris 138 lbs. In all bones the pattern was on the superior aspect of the neck and the latero-anterior aspect of the shaft, the areas subjected to tensile strain. The location of the pattern on the shaft varies with the shape, thickness and curvature of the bone. The angles the neck shaft and vertical axes make with one another, the amount of compact and spongy bone and their physical properties, species, age, sex and state of health also influence the weight supporting capacity of a bone. All patterns obtained in the femurs of non-human primates could be closely duplicated in various human femora. The mechanical behavior of all the bones, as indicated by the "stresscoat" pattern, was essentially similar. The human femur appears no better adapted for supporting a vertically applied load, as in the erect posture, than the femurs of the other primates studied.

¹ This investigation was supported (in part) by a research grant from the National Institutes of Health, Public Health Service.

8. *Cranial changes in a sequential skeletal series.* Russell W. Newman, QM Climatic Research Laboratory, Lawrence, Massachusetts.

Comparisons of cranial measurements and indices of adult males from three archaeological horizons of Central California are illustrated by means of histograms. The visual analysis gained by this method gives insight into trends from horizon to horizon that are difficult to detect by the standard statistical analysis. It is concluded from an inspection of trends that the maximum change occurred between the first two of the three sequential time periods, a conclusion not apparent in the tabulated statistics of the same material.

9. *Preliminary observations on the human skeletal remains from Conkling Cavern, New Mexico.* T. D. Stewart, U. S. National Museum.

In 1929 Mr. Roscoe P. Conkling explored a cave, which now bears his name, on the lower easterly slope of Bishop's Cap peak in southwestern New Mexico (see Science, vol. 70, p. 39). This cave descended vertically from a small opening for a distance of about 12 feet to a floor. Excavations through the floor revealed a human skull fragment (no. 1) at the further depth of about 12 feet. From here down for about another 8 feet, were bones of sloth, bear, horse, camel and human (limb bones). At about the 20 foot level was a hard sandstone layer 2 to 4 inches in thickness which appears to have been water-laid and extended throughout most of the cave. About 18 inches below this layer part of another human skull was found (no. 2).

Because of the probable antiquity of these human remains and the fact that they have never been described, I requested permission of the Los Angeles County Museum to study them. This request was kindly granted and the specimens are now in my possession.

I shall limit these preliminary remarks to the two skull fragments. No. 1 consists of parts of the parietals and frontal; no. 2 has only the occiput and temporals. I will show how outlines of these fragments fit the outlines of *Novusmundus*. My conclusion is that these skulls do not differ significantly from those of modern Indians.

10. *Adena skull deformation redefined.* Charles E. Snow, University of Kentucky.

A reexamination of the Kentucky Adena crania, some 90 individuals (51 M, 39 F) of all ages, reveals that some kind of circular head bindings were probably used along with the cradle-board to produce the grooves around the high-vaulted, bulging-sided, flat-backed deformed skulls so typical of Adena mound burials. Bas.-Brg. Ht. M(15) 151.7 cm, F(12) 145.9 cm; C. I. M(25) 92.5, F(18) 91.7. Mean Ht. I. M(14) 97.0, F(12) 96.8.

It is surmised that some sort of wrapping was tightly bound across the forehead, above the browbridges, and along the sides of the head above and behind the ears. Here the parietals show a remarkable depression which extends onto the adjoining parts of the occiput just above the nuchal area. In those cases of greatest backhead flattening (82% vertico-occipital, 18% lambdoidal) the frontal bone is sharply bent, the parietals are foreshortened, bent up to form a high crown, and bulged out sideways. The compensatory reshaping (pseudo-circular binding) has formed the characteristic, noteworthy rounded "block-heads" of vast height. Some skulls have bifrontal planes which suggest the use of pads under the bindings.

Nine individuals ($\frac{1}{10}$ of series) appear to be undeformed. It is a matter of conjecture why this cultural mark was not pressed upon at all. It will be remembered that all Adena skeletons come from ceremonial burial mounds (some of great size) and thus are a selected group. It is believed that here is a complex problem involving combined factors of infant care, physical force, growth, social-class status and ceremonial burial selection. It is possible that some kind of hair-halter or other ornamental head-dress was worn to show off the highly valued, well-formed (deformed) heads.

11. *The blood groups of Alaskan Indians.* Victor E. Levine, Department of Biological Chemistry and Nutrition, Creighton University School of Medicine, Omaha, Nebraska.

Since there are no data on the blood groups of the Alaskan Indians, a study was made of 120 pure-blooded members of the Tlingit tribe of southeastern Alaska. The results follow:

Group O, 75.83% ($p = 0.129$) and group A, 24.17% ($r = 0.871$). Groups B and AB were absent. All in group A fell into subgroup A₁. Type M, 72.50% ($m = 0.858$) type MN, 26.67%, and type N, 0.83% ($n = 0.142$). Rh factor, 100%. The results agree surprisingly well with those obtained by Boyd and Boyd (American Journal of Physical Anthropology, 1949, 7, 569-574) on the Navaho Indians of Ramah, New Mexico.

American Indians fall into three divisions with respect to groups O, A, B, and AB: (1) those with a preponderance of group O, (2) those with a preponderance of group A, and (3) those with a considerable incidence of both groups O and A. The Tlingits come into the first division.

The Tlingits of Alaska resemble their northern Eskimo neighbors in the absence of subgroup A₂, in the very low incidence of type N, and in the 100% positiveness of the Rh factor. They differ, however, from the Alaskan Eskimos in the preponderance of type O and in the absence of the groups B and AB.

12. *Change in stature after maturity.* Mildred Trotter and Goldine Gleser, Department of Anatomy, Washington University, St. Louis.

The stature of an individual after maturity may decrease with age, the result of changes in the vertebral column, of thinning of weight-bearing cartilages in other regions and of loss of muscular strength. The average statures of successive generations of a population may differ, the result of secular changes. Consequently, average statures of successively older groups of individuals from the same population at the time may be affected by both age and secular changes.

In statures of 855 cadavers (whose skeletons are now a part of the Terry Anatomical Collection) the aging factor has been separated from the secular factor in order to determine the average amount of decrease in stature resulting from the aging factor. This was feasible since the length of long bones does not change after maturity and since a high correlation exists between their length and stature. The change of stature with age which is not attributable to differences in bone length was obtained by means of partial correlations for groups of Whites and Negroes of each sex. A statistical significant decline was found for each sample. The rate was uniform in all groups amounting to an estimate of 1.2 cm per 20 years. This rate of decrement was likewise found to obtain in Rollet's data (1888), based on 50 male and 50 female French cadavers. Thus, it is indicated that this rate of decline in stature is applicable to the general population.

13. *Factors of human physique.* W. W. Howells, University of Wisconsin.

It is suggested that anthropometry, as a study of variation in physique, stands in need of new statistical techniques. Heretofore, analysis has typically consisted of comparing the means and variability of individual measurements, new possibilities might appear for research in growth and in all forms of differential development (race, sex, constitution, etc.), and the usefulness or significance of different measurements to a smaller number of factors, which not only clarify the relations of different measurements but are also capable of meaningful interpretation themselves. An example of one type of factor analysis is shown. These techniques were invented by psychologists, and have been applied several times to physical measurements, but not heretofore by anthropologists, and in no case to data which were obtained especially for the purpose; their worth has therefore not been properly tested. Interesting results have been obtained, however, by the author and others. Trunk and limb development always appear relatively independent, as do the brain case and the face; and lineal and lateral factors are distinguishable in these regions. Bizygomatic breadth, for example, appears as a linear combination of two independent factors for cranial breadth and facial breadth respectively. More research would be needed to distinguish or isolate such factors more definitely.

14. *The selection of maturational criteria in growth studies.* Stanley Marion Garn, Forsyth Dental Infirmary.

Maturational criteria are employed in growth studies and in clinical practice in order to estimate the degree to which an individual has reached maturity—the “steady-state.” Such criteria are varied and include osseous development, sec-

ondary sexual characteristics, and excreted steroids. Even a single criterion, such as "carpal age" is influenced by different hormones at different maturational stages. Hence it is often necessary to determine which criterion is the best indicator of a particular maturational stage.

In relating the emergence of the second molar to physiological maturation in girls, both areolar development and the appearance of pubic hair are possible criteria. Using either areolar stage or pubic hair stage, future growth can be predicted with a fair degree of accuracy. The question is, which is the more useful criterion?

Of the two measures, areolar development appears to be more satisfactory. In over 90% of girls, areolar enlargement is the first sign of the steroid growth phase, while pubic hair development is not only later (in most girls) but is more variable in pattern and extent, and it may be either sparse or well developed at menarche. Moreover, areolar development appears to be conditioned by steroids of ovarian origin that also promote epiphyseal unions.

In using areolar stages as maturational criteria, we have been able to follow the sequence (but not the norms) described by Reynolds and by Pryor. The Forsyth series is earlier in areolar development than Pryor's series, and later than Reynold's. Differences also exist between the Forsyth series and the Harvard (Stuart) series.

15. Morphological patterns in limb deficiencies and duplications. Ronan O'Rahilly, Department of Anatomy, Wayne University.

Recorded cases of human paraxial hemimelia (absence of one forearm or leg bone) have been analyzed in order to find the incidence of involvement of individual carpal and metacarpal bones. The rule of Otto and of Davaine has been amplified: radial hemimelia tends to be accompanied in more than 80% of cases by absence of the scaphoid, trapezium, and first metacarpal, whereas the lunate, trapezoid, and second metacarpal, are present in more than 85%. Radiostyloid deficiency tends to be associated with hypoplasia of the scaphoid, trapezium, and first metacarpal; such a case (intercalary radial hemimelia) with "le pouce flottant" is illustrated. In ulnar hemimelia the pisiform and hamate (and frequently the triquetrum and capitate) and some of the ulnar metacarpals are generally absent. By contrast with the upper limb, in tibial or fibular hemimelia, individual tarsals and most of the metatarsals are more frequently present than absent.

The characteristic appearances of polymelia may occur in (a) a double formation where the full limb complement fails to differentiate; (b) a single individual where the lower limbs fail to separate (symmelia); (c) a single individual where duplication of a limb or of limb parts occurs. A rare example of group (c), a case of mirror-image doubling of the ulna and hand, is illustrated. Ulnar dimelia is usually associated with double radial hemimelia and the carpal arrangement in such cases confirms the typical absence of scaphoid, trapezium, and first metacarpal, in the presence of duplication of the other elements.

The characteristic morphological patterns described are discussed and the embryology of the anomalies is reviewed.

16. *Procedure for determining refractive index of hair with some preliminary findings.* Olive: H. Duggins, Department of Anatomy, Washington University, St. Louis.

A modification of the double variation method for measuring birefringence has been applied to human head hair. This procedure involves the use of an Abbé refractometer, constant temperature bath, monochromatic light source, polarizing microscope and certified oils of refraction. Theoretically this method is accurate to $\pm .0005$ of an index point. In actual practice it has been found to be in error as much as $\pm .001$.

Yearly samples of head hair have been measured to date for 4 subjects (2 boys and 2 girls) from birth through 18 years. The birefringence for each of the subjects is quite low at birth, rises rapidly during the first two years, after which it levels off, tending to maintain a value more or less characteristic for the individual. A sex difference in refractive index may be indicated, particularly during adolescence.

17. *An anatomical relationship predisposing to lumbosacral fusion.* Frederick P. Thieme, Department of Anthropology, University of Michigan.

An investigation of lumbosacral fusion cases, included in a sample of 55 medical students and in a sample of 82 skeletons derived from dissecting room cadavers, revealed a very significant relationship between fusion and the spatial arrangement of the anatomical elements in the sacral-pelvic complex. It was found that in the fusion cases a particular relationship existed between the plane described by the ileo-pectineal, or arcuate, lines and the sacral promontory. In all cases of fusion, the sacral promontory was recessed downward toward, or below, this plane. This was in contrast to the non-fusion cases where the point of intersection was always farther above the plane, and never below it. An analysis of the anthropometric measures from the samples demonstrated clear statistically significant differences in this relationship between the fusion and non-fusion cases. The frequency of fusion was 10.9% in the medical student sample (mean age 24.4 years) and 18.3% in the skeletal sample (mean age 61.4 years). It was concluded that anomalous fusion may well be the response to mechanical strains introduced by a particular anatomical relationship, probably inherited, which is within the range of normal human skeletal variation.

18. *Physical anthropology and the field of public health.* Marcus S. Goldstein, U. S. Public Health Service. Read by title.

19. *Physique, social class and crime among the Yap islanders.* Edward E. Hunt, Jr., University of Virginia.

The adult male Micronesians of Yap are variable in somatotype, but generally more mesomorphic than the Negroids and Whites of the U. S. Army studied by Hooton. The Whites are the most endomorphic of the three groups, and the Negroids the most ectomorphic.

The Yap islanders are a socially stratified, feudal society with a majority of landlords and a small minority of tenants. These tenants of both sexes are morphologically somewhat different from their masters in their shorter stature and greater incidence of squat, mesomorphic physiques.

About 13%, or 45 out of the 347 young Yap males measured, had been convicted of unlawful acts during the first three years of the American occupation (1945 to 1948). These delinquents were not preponderantly tenants or landlords. In physique, the delinquents differed only slightly from the rest of the series in showing slight excesses of mesomorphs and endomorphic ectomorphs.

The delinquents were then divided into subgroups according to the nature of their offenses. Men convicted of violent attacks on the persons of others included all individuals whose mesomorphy exceeded 5. Other types of delinquents were therefore less mesomorphic, and the larceny group especially clustered in some of the weak, skinny somatotype classes.

Evidently some of the correspondences of physique, behavior and social status found in Western civilization may be at least partially cross-cultural.

20. *Anthropometry and clothing size.* Robert M. White, Quartermaster Climatic Research Laboratory, Lawrence, Massachusetts.

There are 4 main fields in which the techniques and procedures of physical anthropology may be utilized in connection with military problems. Anthropometric data may be used in developmental work on military clothing and equipment, in investigations of body types in the military population, in identification of war dead, and in the development of prosthetic devices for war casualties. In the Army program of research in physical anthropology, anthropometric data have been used primarily in work on military clothing.

The development of a theoretical system of sizes for a functional jacket may be used as an example of the applications of anthropometric data in this type of work. Stature and chest circumference are selected as the controlling dimensions. Basic reference data are in the form of a bivariate chart showing the distribution of values of these two dimensions in the military population.

With assumed tolerances of three inches in each size, a size system of 25 sizes will be necessary to accommodate 15-inch ranges of stature and chest circumference in the military population. The number of sizes may be reduced to 16 or 15 by increasing the tolerances in each size.

The correct location of the size system with respect to the distribution of body measurements in the population is determined by the ranges of stature and chest circumference to be covered, together with the relationship between the two dimensions. The result is a system of 9 sizes which fulfills the basic requirement of maximum coverage of the population with a minimum number of sizes.

21. *Air force anthropometry in 1950.* H. T. E. Hertzberg and G. S. Daniels, Wright-Patterson Air Force Base, Dayton, Ohio.

This paper points out the opportunity for varied research in applied anthropometry and calls for greater participation by young men. It describes and dis-

cusses the salient points of several studies and their application to Air Force problems. These are listed as follows:

1. *Anthropometric survey.* One hundred and thirty-two measurements, some sociological data, and 4 somatotype photographs were taken on about 4,050 Air Force flight personnel. About 35 measurements were new to anthropometry. Some are described and illustrated.

2. *Foot pedal angle-and-torque study.* Slides of apparatus and polar graphs showing the angles of most effective torque application. Formal report awaiting issue.

3. *Prone position study for pilots.* Described previously in this Journal. The bed has been mounted in an F-80 for evaluation in high-performance conditions. Illustrations.

4. *Center-of-gravity studies.* A method of calculating the center of gravity of an average man for any position or condition of equipment load has been developed. It employs the method of moment forces and uses reasonable approximations to the weight and c.g. of body segments.

5. *Stick grip for fighter airplanes.* A study to develop a comfortable and functional stick grip for use in fighter airplanes. Entirely new instruments were designed to measure a concave surface—the inside of the gripped hand. This subject is fully discussed in another paper.

Plans for 1951 are outlined. The program is important, socially useful, expanding, and offers real opportunity for qualified persons.

22. *A comparative quantitative analysis of finger tip patterns.* David C. Rife, The Ohio State University.

The quantitative values of the finger tip patterns of approximately 4,000 persons were determined from their finger prints. Whorls, loops, and arches were assigned values of two, one, and zero respectively. Individuals were classified as to sex, religion, and national origin. Comparisons were then made between the total pattern values of right and left hands, and between each of the above groups. Right hands possessed higher pattern values than left, men had higher pattern values than women, while with respect to religion Jews showed the highest pattern values, Catholics the lowest, Protestants being intermediate. Northwestern European Protestant males were characterized by higher pattern values than were British Protestant males. Right hands were more variable than were left hands. A statistical analysis of the data was made by the statistics laboratory of the Ohio State University.

23. *An operational approach to the primate cerebral cortex.* Berry Campbell, Department of Anatomy, University of Minnesota Medical School.

The status of the cerebral cortex, operationally considered, resembles that of physical anthropology in general before exact measurements and statistical theory were demanded. Few authors, notably Bok, have made analyses equivalent in their rigorosity to those appearing in the literature dealing with osteological and body size studies. The "species problem," well known to biology in general

and thoroughly familiar to human taxonomists, is the main impedance to problem in the study of the cerebral cortex. The literature shows confusion of variation with speciation. Brain parcellers, lumpers and splitters alike, have erected types which were no more than arbitrary loci on a continuously varying pattern. Historically, the constant preoccupation with prior functional interpretation has played an important part in the involvement in this error of logical structure. From the time of Gall, the cortex has been examined with the principal object of demonstrating the morphological basis of sound or transient physiological and clinical facts.

Operational methods by which the cerebral cortex may be studied *per se* are discussed and illustrated. The frontal lobe is discussed in detail. A provisional map is introduced illustrating the continuous nature of change in cortical pattern and showing the uniquely high gradients of pattern change at the Rolandic fissure and at the edge of the striate cortex.

24. An improved cephalometric technique for animal experimentation. C. W. Asling, Division of Anatomy and Institute of Experimental Biology, University of California, Berkeley.

Deviations from normal head form in rats have been observed repeatedly in the course of experiments involving endocrine deficiencies (as hypophysectomy and thyroidectomy), endocrine therapy (especially growth hormone and thyroxin), and nutritional deficiencies (such as in protein and folic acid). Roentgenograms taken primarily for determination of skeletal maturity have confirmed the impression that both cranial and facial components of the skull partake in the alterations. Heretofore, lack of certainty that the positioning of the head for roentgenograms was always comparable has prevented a detailed analysis of the growth mechanisms involved. A technique similar to Broadbent-Bolton cephalometry was necessary, especially for serial observations.

An apparatus for stabilizing the head of anesthetized rats has been devised.¹ Three-point fixation (at upper inter-incisal space and in external auditory meati) is available, with adjustable pressure at all points to compensate for head size. For dorso-ventral roentgenograms the points are held in a horizontal plane; for lateral projections the entire support (carrying both head and body) is rotated 90 degrees on the midline of this plane. The plane coincides well with the basi-cranium.

This presentation is restricted to illustrating some of the earlier observations mentioned, to demonstrating the apparatus and measuring technique, and to outlining the experiments now under way or immediately to be undertaken.

¹Dr. Leo Estel collaborated in the construction of the first model and in the analysis of its deficiencies in performance.

25. Demonstration of the Kentucky skull rig and of a new type of dial reading spreading caliper. Charles E. Snow, University of Kentucky.

26. *Historical sources of the sense of problem in anthropometry.* J. N. Spuhler, Institute of Human Biology, University of Michigan.

Compared to the more dynamic fields of contemporary biology, anthropometry is an "old" science. The essential concepts and methods of classical anthropometry developed during the 16th to the 19th centuries. This development was closely related to that of 5 scientific fields: comparative anatomy, heredity, systematics, theory of evolution, and statistics. If one accepts the basic biological theories current during the period when anthropometry was established as a science, the vast program laid out by the founders of anthropometry makes "good sense." Given their basic assumptions, anthropometry provided a secure means to achieve their goals.

The general philosophy of science used by classical anthropometry is not an isolated case. It has characteristics of much of pre-20th century biological thought. There was right stress on objective and meticulous gathering of data; but relatively little emphasis on the framing of appropriate hypotheses, relatively small concern with conceptual apparatus in general.

Differences between 19th and 20th century statistics enlighten the contrast between classical anthropometry and the newer physical anthropology. In classical anthropometry statistics remained an adjunct of description. In contemporary human biology mathematics often provides a method of analysis. Nineteenth century anthropometry made little use of statistical models for interpretation and explanation of empirical results, in contrast, for example, to the present situation in population genetics. Descriptive use of statistics and early acceptance of a blending theory of heredity had much to do with the overly rigid standardization of anthropometric techniques and sense of problem.

27. *Rudolf Virchow (1821-1902) and anthropometric standards.* J. Lawrence Angel, Daniel Baugh Institute of Anatomy of the Jefferson Medical College, Philadelphia, Pa.

This pioneer in anatomy, pathology, preventive medicine, liberalism, anthropology, and scientific objectivity has been called the Newton of medicine. Boas wrote in 1902 that "among the men who laid the foundations of this science (physical anthropology) no one has done more to shape, guide, and foster it than Rudolf Virchow."

The Pomeranian Virchow gained an international reputation at 27 just before he was forced from Berlin to Würzburg by his fight for democracy. After his proof of the cell as key unit in genetics, growth, and function as well as structure and his recall to head his Berlin Pathological Institute (1856) he ruled German science, remaining deeply critical, thorough, energetic, versatile, productive (over 2,000 papers), a devoted parent, and Reichstag reformer and champion of the common people.

As anthropologist he sarcastically opposed all hypotheses, seeking concrete data to test evolution theories and starting research journals and societies (1870). He wanted a cellular basis for genetic change, but devised no experiments. Instead he elaborated the metrical approach through many disputes, with techniques, instru-

ments, and useful standardization (e.g. Frankfort, 1884). Thus his measurements (1879) on 14 ancient Greek skulls deviate from mine (1939-49) by less than 1%. His descriptions are models of vividness; and work on the skull base (1857) and cretinism led him to stress the vanity of using adult morphology apart from growth and function. Yet in spite of his ridicule the later metrical schemes became hydras of rigidity which we are only now dominating with help of modern genetic concepts and Virchow's own emphasis on understanding of growth processes.

28. *A historical survey of anthropometric instruments.* Lucile E. Hoyme, Washington, D. C.

Anthropometric instruments, as discussed in this paper, are instruments devised or generally used for anthropologically oriented studies. They may be used for drawing, for measuring, or as accessories. Most anthropometric instruments are designed to measure at least one of the following characteristics: Length, height, radius, surface area, volume, and weight; a few are multipurpose.

Although a few anthropometric instruments were described prior to 1860, the majority were described after that date. Of the instruments most frequently found in anthropological laboratories today — sliding and spreading calipers, anthropometer, dynamometer, mandibular goniometer and osteometric board — the majority were adapted for anthropometry by Broca before 1880, and have undergone only minor modifications since that time.

The evidence presented in this preliminary report seems to indicate that the simpler and more versatile instruments are more likely to be generally adopted than complex ones, or those serving to take only one measurement; that there has been a general decrease in the number of instruments used, paralleling a decrease in number of measurements taken; and that there has been a tendency to reinvent virtually the same instrument many times. This repeated presentation of essentially the same designs may be due, at least in part, to the lack of familiarity with the wide range of possible designs, as recorded in well over 600 publications describing instruments.

29. *Broca and his area.* Gerhardt von Bonin, Department of Anatomy, University of Illinois.

Born 1824 from Huguenot parents in Sainte-Foy-le-Grande (Gironde), Broca went to Paris to study medicine, attained the doctorate in 1849, and soon became famous as pathologist and surgeon. In active practice all his life, he founded in 1860 with 19 friends the Société d'Anthropologie. In 1880 he was nominated to the Senate. A few months later he died suddenly.

In 1861, during a debate on the localization of cerebral functions, Broca mentioned that aphasic patient "Tan" who soon afterwards came to a post-mortem and was generally accepted as a proof for the localization of speech in the inferior frontal convolution.

In 1906, Pierre Marie found the three brains which Broca had examined in the Musée Dupuytren. The pia had not been removed, and all brains showed lesions in both frontal and parieto-temporal lobes.

Modern cytoarchitectonics identified Broca's area in most primates, and clinicians have cast increasing doubt upon its function.

The brain is indeed the most difficult organ to understand. It is fatefully easy to make mistakes.

30. *T. H. Huxley as an anthropologist.* Jacob W. Gruber, Temple University.

Although Thomas Henry Huxley is known and remembered primarily for his efforts, as "Darwin's bulldog," in behalf of the Darwinian theory of evolution, his scientific interests and contributions covered almost the whole of Biology. Included in these interests was the developing science of anthropology.

During the 1860's in which decade most of Huxley's anthropological writings are concentrated, he approached the study of man much as he did the study of any other organic species. Excluding from such a study any questions of a philosophical nature, he rigidly restricted the field of inquiry to problems capable, in his opinion, of empirical investigation. His primary work was concentrated in the field of racial classification, in which field, as in anthropometry in general, Huxley sought for some objective method of racial description based upon anthropometric techniques and quantitative definitions. In his racial classification he established first 11 and later 9 basic races, of which two were centered in Europe. In keeping with the idea of progress implicit in nineteenth-century evolution, he confidently considered his races to form a hierarchical succession constructed on the basis of evolutionary values attached to physical, mental and moral features. His conclusions with respect to the Neanderthal specimen reflect a similar bias.

Huxley's most significant contribution to physical anthropology, however, was his three essays published in 1863 under the title of *On Man's Place in Nature*. This book, intended to demonstrate the closeness of relationship between Man and the anthropoid apes, set the tone both in method and content for future anthropological studies designed to put flesh upon the skeleton which Huxley constructed.

31. *Bioanthropology as culture history: its value in education.* Earl W. Count, Hamilton College.

I. The final vindication of science is its contribution to thought. An idea is not understood until its history is part of that understanding. Every idea has an intrinsic history — the inner story of its development — and an extrinsic — involving its reciprocal play with its cultural *Zeitgeist*. II. The two most influential contributions of bioanthropology to modern thought — human evolution and race differentiation — are considered under these assumptions. Each has occupied its own peculiar position in the development of XIX century Occidental thought and action. III. Looking forward — scientific positivism is becoming unsteady at the moment when bioanthropology is becoming more vital, but also less certain of the limits of its range. Still less is it clear that bio- and cultural anthropology are fundamentally a single field of interest. The reason lies in our failure to find the frame of common operations, rather than in the singleness of the field. For man remains a Gestalt — a Configuration. And the conceptual principle of configuration is superseding the dominating atomism bequeathed by the XIX century. This historical

survey indicates why we have as yet no Science of Man. The task of anthropologists is to found it, and to secure its place in American education.

32. *The great chain of being and physical anthropology.* William S. Laughlin University of Oregon. Read by title.

33. *The role of physical anthropology in dental and medical research.* Wilton Marion Krogman, Graduate School of Medicine, University of Pennsylvania.

(Address given at the Annual Dinner, March 20. The outline of this address appears in this issue under Brief Communications.)

34. *Physical anthropology in American universities.* Georg K. Neumann, Indiana University.

This analysis of courses in physical anthropology offered at 600 universities and colleges during 1949-50 is based on the data gathered for a survey of anthropology courses made by Dr. Erminie W. Voegelin (*Amer. Anthropol.*, 52: 350-391, 1950). Because physical anthropology is actually in part vertebrate palaeontology, comparative anatomy, human anatomy, embryology, physiology, and genetics, and is very often linked with work in medical schools, it is perhaps inadequately covered from the standpoint of human biology as a whole. Nevertheless, the survey gives an idea of the scope of the courses that are specifically offered as anthropology.

A reclassification on the basis of course content was felt to be necessary. Of the 141 courses offered, 52 dealt with human evolution: the processes of human biology, phylogeny of the primates, or a general survey of the field; 24 dealt with more advanced physical anthropology: often courses of two semesters duration, laboratory work, dealing with data divided into morphological, somatological, experimental, and constitutional work; 21 dealt with problems of racial characteristics, taxonomy, and distribution of races; 14 additional courses dealt with the racial history of specific areas and 8 additional ones with human palaeontology. Courses in which specialized interests are designated are few and will have to be sought in various disciplines of biology rather than anthropology; they are: human genetics 2, constitutional anthropology 1, growth 2, population 2, primate anatomy 2, race mixture 2. Five are merely designated as reading courses, and six as research.

As to the anthropologists themselves, of the 604 that are listed as teachers of anthropology, 65 offer work in physical anthropology. It may be revealing, however, that only 27 are primarily physical anthropologists, while 38 are primarily cultural anthropologists in the fields of archaeology, ethnology, and social anthropology; who generally offer only one course to cover the biological side of anthropology.

35. *A fundamental basis for taxonomic and constitutional typing as propounded by R. Bennett Bean.* E. S. Craighill Handy, Oakton, Va.

Anthropometry and anthroposcopy utilize surface measurements and observations which have little bearing upon the adjustment of organism to environment.

In our "Genethnic" frame of reference for appraisal of individual man within total environment, the morphological systems of the body are taken as the functional "variables" for developmental and clinical record and cross reference. These systems are derived from the three dermal layers of the embryo; thus, from mesoderm are derived the skeletal, muscular, urogenital and vascular systems; from endoderm are derived the digestive and respiratory organs; and from ectoderm are derived the integumental, sensory, peripheral and central nervous systems. These systems, by means of which the organism adjusts itself to environment, constitute a logical basis for systematic appraisal not only of the physique, but equally of build and breed.

In 1923, 1924, 1925 and 1926, in the American Journal of Anatomy, Dr. Bean brought forward a theory of racial evolution, of build and breed, based upon three "types." "Linear" Hypermorphs, with brain large relative to bulk, are the most advanced type. Broad, "Bulky" Mesomorphs, more brawny than brainy, are intermediate. Short, "Round" Hypomorphs are primitive. In his 1923 article in the Journal of Anatomy, and again in an article in 1926 (Quarterly Review of Biology, pp. 360-392), Bean briefly discusses pathology of his three "types": Hypermorphs are particularly subject to diseases affecting ectoderm; Mesomorphs suffer from diseases affecting the mesoderm. He implies, therefore, without expressly formulating, the conception that the embryonic dermal layers, from which the functional morphological systems of the organism are derived, constitute a practicable basis for typing and classification.

36. *Missing teeth with special reference to the population of Tristan da Cunha.* Selma Ø. Thomsen, Tandlaege, Forsyth Dental Infirmary for Children, Boston, Massachusetts.

Missing teeth have been investigated by students in various fields to determine etiology, incidence, racial and sexual differences, and mode of inheritance.

A review of literature reveals: confusing terminology—diverse opinions concerning etiology—rare occurrence in the deciduous dentition—a certain regularity in location and combination of groups of teeth affected in the permanent dentition—a suggestion of racial and population differences in incidence and pattern—a suggestion of sexual difference—various possibilities regarding mode of inheritance.

The material for the present study was gathered by Sognaes in 1938 as a member of the Scientific Norwegian Expedition to Tristan da Cunha. From a total of 188 Tristanites, data on 169 were suitable for study. Missing teeth were appraised from casts and roentgenograms, genetic aspects from complete genealogies dating back to the first settlers in 1816.

The deciduous dentition was not affected. In the permanent dentition only "unstable" teeth were missing, affecting 18% of the dentitions. This figure may be larger since not all groups of teeth could be studied in all 169 individuals. Thus, the incidence is high as may be expected in such an inbred population. Previously reported groups range from 1-5%. The rank order of missing teeth ($M_3 > P_2 > \text{Mand. I} > \text{Max. I}_2$) is similar to that in most reports, with the exception that max. I_2 is less often missing than any other tooth.

Males generally showed a higher incidence than females, but this difference is not significant, nor are the differences in incidence between the jaws, and right and left sides.

All degrees and combinations of groups of missing teeth are demonstrable.

In the Tristanites the trait behaves in most pedigrees as a recessive. In a few pedigrees it appears dominant, probably due to the high degree of inbreeding.

37. *Frequency of dental abrasion in the South American Indians.* Antonio Santiana, Museo Etnográfico, Quito, Ecuador. Read by title.

38. *Environmental growth factors and selective migration in Mexicans.* Gabriel Ward Lasker, Wayne University College of Medicine.

A Viking Fund grant made possible observation of 480 adults in Paracho, Michoacán. Measurements were taken of 185 male and 23 female adult Mexicans who had been in the United States for various periods of time, and of 111 male and 158 female sedentes. Comparisons indicate that:

1. In general migrants of both sexes are larger than sedentes.
2. Among male migrants those who went to the United States for longer periods of time or at younger ages are, on the average, larger in most respects than those who went for shorter periods or when older.
3. With a few exceptions that are ascribed to age changes, there is little difference in any dimension between sedentes and migrants who first went to the United States after the age of 27 — whether for a shorter or longer stay.

As the factor of selective migration would be expected to influence those who went to the United States after the age of 27 as well as those who went at younger ages, while any environmental growth factor would not, the present findings lend no support to the hypothesis of an appreciable physical selection of the migrants in this study, but confirm the existence of environmental growth factors acting on Mexican immigrants who first came to the United States while still growing. A more abundant diet in the United States may be a major factor of this kind.

39. *Inbreeding coefficients of the Ramah Navaho population.* J. N. Spuhler and Clyde Kluckhohn, University of Michigan and Harvard University.*

Inbreeding coefficients were calculated for 307 matings which produced 1060 offspring during 7 generations of the Ramah Navaho population. Data used were collected by members of the Ramah Project of Harvard, especially Clyde Kluckhohn, Katherine Spencer, Janine Chappat and Nan Stoller. Genealogies date from about 1820 to 1948, but the present population was established about 1870, after the Navahos returned from Bosque Redondo.

The inbreeding coefficient (Wright, '22) $i_0 = \Sigma [(1/2)^{n-1} (1-i_A)]$, where n is the number of steps in the inbreeding loop connecting the inbred individual 0 and the common ancestor A , and summation is over all loops. If A is not inbred, i_0 reduces to $\Sigma (1/2)^{n-1}$. As a check on the above the pedigrees were classified by relationship of husband to wife, and i_0 was obtained by Haldane's method: e.g., i_0 for full r th cousins s times removed $= 2^{-2r-s-2}$.

Of 307 sibships, 124 were inbred. The i₀ range for inbred sibs is .0010—.0977, and the arithmetic mean is .0172. The mean for the total population excluding immigrants (4.4%) is .0068.

The value .0068 is a minimum for the population. If any of the 14 individuals in the initial generation were inbred or related in unknown ways, means for the population would be increased. Coefficients of the order observed (mean .68%, maximum 9.77%) are small compared to such regular systems as brother-sister mating (1 generation 25%, 2 generations 37.5%, etc.) or single full first cousin mating.

40. *Age incidence of separate neural arch in the Eskimo and Aleuts.* T. D. Stewart, U. S. National Museum.

Twenty years ago when I reported the unusually high incidence of separate neural arch among Eskimos, I accepted the prevailing opinion as to the cause of this condition, namely, that it was hereditary. As a result, I neglected to analyze the age incidence. Recently Dr. Thieme has concluded, by inductive reasoning, that this condition is not hereditary, and that a mechanical factor is involved. He thinks the incidence increases with age from birth.

I have verified the correctness of this view by analyzing the age incidence of separate neural arch in 786 Eskimo and Aleut (including Kodiak) spines. Only 4.3% of these defects were found in the group under 6 years of age (once in 23 cases). At 12 years the percentage had arisen to 11.5%. At 18 it was 14.5%. At 24 it was 16.9%. After 24 and as long as arthritis was absent (perhaps to 30 + years) the incidence increased to only 17.2%. But with the development of slight arthritis (perhaps by 40 years) there was a great increase in the arch defect—to 33.9% (77 times in 227 cases). This incidence did not change with increasing arthritis.

The data on the Aleutians and Kodiak are entirely new. The incidence is higher here than for the area of the Yukon and south to Bristol Bay. In 191 adults separate arch occurred in 55 or 28.8%; in 84 sub-adults it was found in 13 or 15.5%. The problem is still to account for such regional differences.

41. *The ischio-pubic index of the people of Indian Knoll.* Glenn G. Stille and Charles E. Snow, University of Kentucky.

The measured innominate bones of 295 individuals from Indian Knoll provide an adequate sample of the earliest known prehistoric population in Kentucky. Of these, a selected sample of 151, composed of only complete left adult hip bones (M-96, F-55) is compared with the series of American White and Negro, African Bantu and Bushman innominates studied by Washburn.

Although these early Indians were rather small and gracile, the average pubic lengths of both sexes exceed those of the other groups. Contrariwise, the lengths of the ischium tend to be smaller than the others. The resulting, useful ischio-pubic index of the Indian Knoller's (M-91.2, F-104.3) is accordingly very distinctive and averages higher than any group described, including the "exaggerated" female Bushman pelvises.

Although the sex differences (17.2% overlap) are of the same order as the others, the high I-P. index values fall to the right of the usual 90-91 line placing the Indians, male and female, definitely on the side of the world's women.

Now these are regarded valid differences of the series since a careful check upon technique was satisfactory. It is not clear whether these marked Indian differences reflect simply the morphology of their different heredity or some functional adaptation to their riverbank subsistence, or both.

A new method of illustrating the distribution of the ischio-pubic index of the 5 series, in cutouts, male and female, was demonstrated, along with tables of measurement data.

42. *Applied anthropometry of the hand.* H. T. E. Hertzberg and G. S. Daniels, Wright-Patterson Air Force Base, Dayton, Ohio.

With the advent of high speed aircraft, the need for greater centralization of aircraft control has gradually resulted in the placing of many of the control functions of the fighter airplane directly on the stick grip. Previous grips of this type have been designed mechanically. The problems of size and comfort, and indeed, operational ease, have all been thought of as secondary design features.

The present study has attempted to reverse this procedure by considering the man first in the design of a stick grip.

A primary study was made to determine the offset angle of the grip axis and, concurrent with this, data were gathered on the range of rotation of the hand on the wrist in the cockpit situation.

A second study was then conducted to measure the configuration of the heel of the hand and the thumb in the most comfortable gripping position. The position measured in each case was that considered most comfortable by the individual subject and was done for both the bare and the gloved hand. This was accomplished by means of a specially designed device arranged at the previously determined offset angle.

With the material obtained in these studies, a stick grip was designed following the mean configuration found most acceptable to the group of subjects measured.

Finally, a working model of the design will be submitted to a series of subjects for comments and suggestions for possible further improvements.

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EDITORIAL

GENETICS AND PHYSICAL ANTHROPOLOGY

Recently there has been a tendency to contrast genetics and physical anthropology as if they were *necessarily* opposed. Some deny the utility of anthropological methods for racial analysis, while others find the genetic concept of race unrealistic. We think that the basic idea of race is the same no matter whether races are described in terms of anatomical traits or gene frequencies. Races are large groups which differ in heredity. If all mankind mated in a random manner, there would be no races. Partial isolation is caused primarily by geographic factors, reinforced by custom. Since there is partial isolation, genetic distinction may develop. These distinctions between the varieties of mankind may be described either in terms of anatomical traits (phenotypes) or gene frequencies. Both may be used together, as a race may be characterized by skin color ranging from dark brown to black, hair curly to very kinky, and a high frequency of the gene Rh^o. There is no contradiction or conflict in the use of both genotype and phenotype in the description of races.

If the genetic basis of a trait is known, it is possible to describe the situation much more clearly and precisely. Mutation can only be discussed relative to a particular gene. Genetic drift can be investigated only if population size and gene frequency can be estimated. The results of migration and hybridization can be stated precisely if gene frequencies are known, and the outcome of future crossing can be predicted. Selection acts directly on the phenotype, and causes evolution by changing gene frequency. Precise, quantitative statements of the process of race formation and of the differences between races can only be made in terms of genetic

information. Anyone trying to understand the races of man who does not use the available genetic information gives himself a serious, unnecessary handicap. But anyone who does not use the anatomical information is equally shortsighted. There are hereditary variations in the form of the nose, teeth, muscles, and many other parts of the body. These variations occur in different frequencies in various races. A full description of racial differences and of the causes and process of race formation must take these phenotypic differences into account. Complete understanding of a gene involves knowing its expression in the phenotype and its significance to the organism (not just its frequency in the population). Similarly, full understanding of an anatomical trait involves knowing its genetic origin. The more that is known of human genetics, anatomy, and ecology, the more will be known of races and the process of race formation.

The races of man should be the same whether arrived at by genetic or anatomical methods. The number of large, partially reproductively isolated groups should not be changed by the method of investigation. Naturally, as knowledge increases, our ideas of the degree of distinctness of a race or of the interrelations of races may change. For example, hypotheses concerning the relation of the Bush race to other African groups will vary, but there is just one such group no matter how its anatomy is described. There is no conflict between genetic and anatomic methods of studying races, provided the descriptions are based on populations and the same concept of evolution is used. If races are based on types selected from breeding populations, then genetic and anatomical races will be different. Likewise, if the outmoded concepts (orthogenesis, irreversibility, exclusive use of non-adaptive traits, or arbitrary sorting methods) are used, then anatomical and genetic races may be different. Since many of the human races in the literature are based on these erroneous concepts, at the moment there may appear to be a conflict between the methods of genetics and anthropology. But this appearance is superficial and misleading. Human genetics and human

anatomy supplement each other, and both are necessary for the understanding of race. As knowledge of human genetics advances, the apparent barriers between genetics and anatomy should disappear.

HERLUF H. STRANDSKOV
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CONGRES D'ANTHROPOLOGIE DIFFERENTIELLE.—The first *Congres d'Anthropologie Differentielle* was held on September 11 to 16, 1950, at Royaumont, bringing together numerous scientists such as Prof. Baumann of Geneva, Prof. Hanhart of Zurich, Prof. Pende of Rome, Prof. Eysenck of London, three assistants of Prof. Kretschmer of Tübingen, Prof. Falkenburger of Mainz, and Professors Laignell-Lavastine, Heuyer, Decourt, Max Jayle, Ajuriaguerra, Delmas, Mayer, Doctors Bize, Cavel, Leibovici, Pierre Mabilie, Martiny, and Tisserand, of Paris, etc. etc.

The meeting was presided over by Prof. Joannon, professor of hygiene and preventative medicine, of the Faculty of Medicine of Paris. It was organized by the *Société de Morpho-physiologie Humaine*, and Dr. Pierre Mabilie served as Secretary General. This Congress has as its aim the study of all those anatomical, physiological, psychological, genetic and evolutionary elements which differentiate individuals and give them distinct personalities.

As is known, ever since the time of the Greeks, physicians, artists and philosophers have endeavored to classify individuals according to constitutional type and temperament. Up until recently, such systems rested on theoretical conceptions having varying degrees of justification, which explains the great variety of them, and their unreliable character. Nowadays work must be undertaken on the basis of exact measurements, rigorous clinical observations, and tests of a physiological as well as psychological nature.

In the course of the sessions, it became apparent that the different techniques used by different schools be standardized, and the terminology also. To this end there was created a *Bureau International*

d'Anthropologie Différentielle, charged with coordinating efforts in this direction.

The program of the Congress follows.

Monday, September 11

- Pr. Joannon: Address of welcome.
 Pr. Pende (Rome): Biotypologie et facteurs endocriniens.
 Pr. Pablo Ortega (Mexico): Les caractères typologiques et physiques des scolaires — Index d'équilibre morphologique.
 Pr. Laignel-Lavastine (Paris): Mon cheminement relatif à la biologie humaine différentielle.
 Dr. Pierre Mabilhe (Paris): Stabilité et Labilité des Structures.
 Pr. ag. Ajuria Guerra, Diatkine et Mme Soubiran (Paris — Travail du Centre de reeducation psychomotrice et du langage. Hospital H. Roussel): Tonus et types psychomoteurs.
 Dr. Cavel (Paris): Le rendement fonctionnel moteur dans l'enfance et l'adolescence — Les performances physiques normales dans les 2 sexes, aux différents âges.

Tuesday, September 12

- Pr. Baumann (Genève): Les différents systèmes de classification des types humains et les diverses méthodes de mesures et de recherches. Leur influence sur la terminologie en biotypologie.
 Pr. Vallois (Paris): Anthropométrie et typologie.
 Pr. Pittard (Genève): Quelques appréciations pratiques de l'anthropométrie.
 Pr. Falkenburger (Mayence-Paris): La craniotrigonométrie et les corrélations crâniennes.
 Dr. Pankow (Tubingen): Les données de la croissance de la base du crâne et leur portée pour la constitution humaine.
 Dr. Olivier Janneret (Genève): Une variété sthénique de la constitution sous-mésoblastique.
 Dr. Wunsche (Munich): Différenciation constitutionnelle dans la formation du visage.
 Pr. Saller (Munich): Devoirs et possibilités d'un diagnostic constitutionnel exact.
 Dr. M. Martiny (Paris): Anthropologie différentielle et intoxications professionnelles.
 Dr. P. Vannier (Paris): Conception synthétique de la typologie du point de vue clinique et thérapeutique.
 Dr. Ducruet (Salins-les-Bains): La morpho-physiologie humaine vue par un praticien.

Wednesday, September 13

- Pr. Max Jayle (Paris): L'intérêt du dosage des stéroïdes urinaires en endocrinologie.
 Mme. le Dr. Vallin (Paris): Action des hormones sexuelles sur la morphologie féminine.
 Dr. E. Boltanski (M. H. Paris): Les corrélations morphoendocriniennes et l'asymétrie corporelle.
 Mlle le Dr. Tisserand, Ceccaldi et Samson (Paris): Etude physique, chimique et statistique de la pigmentation rousse des cheveux.
 Pr. ag. J. Decourt (Paris): Les constitutions sexuelles et leurs déviations.
 Pr. ag. J. Vague (Marseille): Le développement de l'appendice xiphoïde. Ses rapports avec celui du thorax et avec la différenciation sexuelle.
 Dr. Steinwachs (Tubingen): L'écriture, test psychomoteur.
 Dr. Luthé (Hamburg): Les possibilités d'application de l'électroscriptographie.
 Pr. M. Jacquet (Reims): Les types circulatoires.

Thursday, September 14

- Pr. Hanhart (Zurich): Aspects théoriques et pratiques de la génétique humaine. Système des maladies et anomalies héréditaires de l'homme.
 Pr. Franceschetti et W. Taillard (Genève): Le problème du linkage chromosomique chez l'homme.
 Mr. Kherumian (Paris): Les typologies sérologiques.
 Pr. Ernst Kretschmer (Tubingen): Typologie et constitutions psychiâtriques.
 Dr. P. Male (Paris): Le problème constitutionnel dans ses rapports avec le développement instinctivoaffectif.
 Mlle Beizmann (Paris): Niveau structural et test de Rorschach. Etude comparative de quelques groupes d'enfants: Normaux, sourds et muets débiles et caractériels. (Travail du Laboratoire de Psycho-Biologie de l'enfance, Pr. Wallon.)

Friday, September 15

- Pr. Heuyer et Leibovici (Paris): Typologie et productions spontanée de l'enfant.
 Mme. Minkowska (Paris): La typologie constitutionnelle vue à travers le test de Rorschach et les dessins d'enfants.
 Pr. José Peinado Altabe (Mexico): Corrélation entre la capacité d'apprentissage et l'équilibre affectivo-émotif.
 Dr. W. Kretschmer (Tubingen): L'arréiation biologique comme base de l'évolution neurotique.
 Mme le Dr. Pourchet (Rio-de-Janeiro): Typologie constitutionnelle et ses applications pédagogiques.
 Mr. Talarie (Gueret): Notes sur le développement affectif de l'enfant.
 Pr. Eysenck (Londres): Les dimensions de la personnalité et la conception du problème neurotique.
 Dr. Minkowski (Paris): Le courant psycho-anthropologique en psycho-pathologie et plus particulièrement dans le chapitre de la typologie constitutionnelle.
 Dr. Dublineau (Paris): Le facteur évolutif et le problème typologique.
 Pr. A. Ombredane (Bruxelles): Le vocabulaire psychologique.
 Mlle N. Bour (Paris): Le test du village dans la sélection des cadres.
 Mlle Stora (Paris): Le test des personnages.

Saturday, September 16

- Travail de l'Institut de Demographie (Paris). Pr. Sauvy, Dr. Sutter et Collaborateurs.
 Dr. Bize (Paris): Les besoins Biopsychologiques et leurs répercussions en Sociologie.
 Pr. Louis Mars (Haiti): Les crises de possession. Typologie et interpsychologie.

THE GEOLOGICAL AGE OF PITHECANTHROPUS, MEGANTHROPUS AND GIGANTOPITHECUS

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INTRODUCTION

While there is still much uncertainty about the exact geologic age of the Australopithecinae in South Africa (Broom, '50), the general opinion among physical anthropologists seems to be that the geologic age of the various types of Early Man in Java, at least, is pretty well settled. In Weidenreich's widely known treatise "Giant Early Man from Java and South China," published in 1945, the opinion is expressed that all the finds of *Pithecanthropus* as well as *Meganthropus* and *Gigantopithecus* are Middle Pleistocene in age, and thus contemporaneous. This statement occurs time and again in the subsequent literature, most recently in Zuckerman ('50, p. 440).

The purpose of the present paper is to point out that this is an oversimplified and, therefore, incorrect presentation of the facts, and to bring together what we really know with certainty about the age of the various finds of Early Man in Asia. From my own studies on the fossil and prehistoric mammals from Java, Sumatra, and India as preserved in the Dubois Collection in Leyden, Netherlands, certain facts have emerged some of which merit consideration here since they do not fit in the scheme of the stratigraphic distribution and succession of the fossil mammals of Java as repeatedly presented by Dr. von Koenigswald since 1934. It may be of importance to present in this paper the modern views held on the age of the Pleistocene vertebrate faunas of Java and elsewhere in Asia, since all the finds of Early Man belong to

certain assemblages of mammals, and it is only through the study of the accompanying faunas that we can learn something about the age of Early Man himself.

ACCOUNTS OF DISCOVERIES OF EARLY MAN IN JAVA

Eugène Dubois made almost all of his *Pithecanthropus* finds at the Trinil locality, on the Solo river 6 miles west of Ngawi in Central Java. Here, as shown by Dubois' field notes now kept in the Leyden Museum, excavations were carried out which were as accurate as those done some 40 years later at Choukoutien in North China. Dubois was able to make out, e.g., that the first femur was lying 15 meters upstream from the skull cap (*Pithecanthropus* I of Weidenreich's classification). The mandible fragment (*Pithecanthropus* A) came from Kedoeng Broeboes, 25 miles E.S.E. of Trinil.

Dubois was convinced that all the fossil vertebrates he collected in Java were of the same age, first decided upon as Pleistocene (Dubois, 1891), and after the first description of *Pithecanthropus erectus* as Pliocene (Dubois, '08). The fossil vertebrates of Java, although Dubois gave names to many of them, remained poorly known until, in 1911, the results of the Selenka expedition to Trinil (1907 and 1908) were published, describing the fauna of the Trinil beds. The age of the Trinil fauna had been settled now as Pleistocene.

It is to Dr. von Koenigswald's great credit that, when he started working for the Geological Survey of the Dutch East Indies early in the 1930's, he distinguished between various consecutive mammalian faunas in the Pleistocene, and also Pliocene, of Java. A wealth of material has been piled up in the Bandoeng Museum, and, as can be seen from von Koenigswald's latest summary of the Pleistocene faunas associated with Early Man in Java (von Koenigswald, '40) the faunal lists are long. Most of the species are but very imperfectly known, however, although they all were given new names.

With the help of certain "guide-fossils" von Koenigswald distinguished between three consecutive Pleistocene faunas, the Djetis, Trinil, and Ngandong. The Djetis fauna comes

from the Poetjangan layers, typically from Djetis, northeast of Modjokerto in East Java, and is distinguished by having morphologically more primitive proboscideans, and a greater number of extinct genera than the Trinil fauna of Dubois. The Trinil fauna is from the Kaboeh layers, which overlie the Poetjangan beds, and is typically developed at Trinil in Central Java where *Pithecanthropus* I was found in 1891. On top of the Trinil fauna comes the Ngandong fauna, typically from a high river terrace on the Solo river N. of Ngawi, in Central Java. In these latter deposits the Geological Survey geologist C. ter Haar discovered, in 1931, the first of the magnificent series of 11 skulls and two tibiae of *Homo soloensis* with which Dr. Weidenreich's latest posthumous publication deals. Solo Man will not concern us especially in the present contribution since it belongs to a Late Pleistocene fauna and is an advanced type of Early Man to which no great age has been assigned.

The Djetis fossils and the Trinil fossils are not only different in faunal composition but also in the nature of their matrix, the Poetjangan layers being clayey while the Kaboeh layers are more sandy and conglomeratic. Nevertheless it is not always easy, on the basis of the adhering matrix, to decide in the laboratory whether a given specimen belongs among the Djetis or to the Trinil fossils, as we shall see below.

Before the first of the new series of *Pithecanthropus* finds was made, von Koenigswald ('34, p. 191) was convinced that *Pithecanthropus erectus* was a member of the Trinil fauna and thus Middle Pleistocene in age. In 1936 "*Homo*" *modjokertensis* was found by a native collector working for the Geological Survey. The find was made in the Upper Poetjangan layers of the north wing of the Kedoeng Waroe anticline, about 8 miles E.N.E. of Modjokerto in East Java. Von Koenigswald considered now that, after all, the first skull cap of *Pithecanthropus* found in the Trinil beds by Dubois showed signs of weathering. Would it not have been possible that this specimen came from the underlying beds with Djetis fauna? The type specimen of *Pithecanthropus erectus* might

very well have been only secondarily deposited in the Middle Pleistocene Kaboeh conglomerates where it was found by Dubois, and could well be originally early Pleistocene in age just as the infant skull from Modjokerto (von Koenigswald, '36, p. 152-53).

This raises, of course, doubt as to the exact age and origin of any fossil specimen derived from the Trinil conglomerates. In fact, Dr. H. de Terra, after personal geological investigations in Java, expressed the opinion that fossils now found in the conglomeratic Trinil bone beds may even be late, or post-Pleistocene in age (de Terra, '43, p. 452). The age of a given fossil from the Kaboeh strata thus must be judged with great caution.

For a number of years Sangiran has been the main center of attraction. In the Sangiran dome, about 8 miles north of Soerakarta in Central Java, both the Kaboeh and the underlying Poetjangan layers crop out, and fossils from either of these deposits can be easily collected along the bases of the hill slopes after heavy rains have washed them out. Thus it is never quite certain whether the fossil specimens came from the black clays of the Poetjangan layers or were derived from the surrounding escarpments of the Kaboeh layers (Van Bemelen, '50, p. 581). Von Koenigswald had trained his native collectors to watch especially for these weathered-out fossils, and this arrangement proved to be very satisfactory, at least for the purpose of finding more *Pithecanthropus* material.

It gradually became evident that fossils of Early Man occur at Sangiran in the ratio of one out of about 10,000 fossil specimens, most of which latter were simply thrown away, although every find was paid for in order not to discourage the natives (von Koenigswald, '47, p. 15). With this rather crude but successful procedure of collecting fossil vertebrates at Sangiran it was possible almost every year from 1937 to 1941 inclusive to put on record a new *Pithecanthropus* find. This impressive series consists of the mandible fragment found already in 1936, the adult skull of 1937, the cranial por-

tion discovered in 1938, the palate with teeth and back portion of a skull found in 1939, and finally two mandible fragments with teeth found in 1939 and 1941 respectively.

Pithecanthropus B, a portion of a right mandibular ramus with P_4-M_3 , was found by von Koenigswald in a collection of Sangiran fossils sent to the Bandoeng Museum the year before, in 1936. It is evident, writes von Koenigswald ('37, p. 884) that the specimen had been lying on the surface for quite a long time; it is strongly corroded. Von Koenigswald, asking his natives about the exact spot where this specimen had been picked up, was told that it came from a spot where the Djetis layers are exposed. However, von Koenigswald's personal opinion, based on the fine-grained conglomeratic nature of the adhering matrix, was that it came from the Trinil layers (von Koenigswald, '37, p. 884). Two years later, after the jaw had been cleared of matrix in the Cenozoic Research Laboratory in Peiping in 1939, it was found that the ramus displayed fine cracks as is known to be the case with fossils from a clayey matrix. It was also found that the ramus is more heavily fossilized than Trinil fossils usually are. On the base of these new facts von Koenigswald ('40, p. 142) decided that this fossil should be assigned to the Lower Pleistocene Poetjangan deposits; the Trinil conglomerate could either have been secondarily cemented to the jaw, or else the specimen had been embedded in a conglomeratic enclosure within the black Lower Pleistocene clay, von Koenigswald holds.

The first piece of evidence of a second skull of *Pithecanthropus* came in 1937 when a native employee sent von Koenigswald a fossil piece of a human-like skull. When von Koenigswald had gone out to the collecting fields he was able to find some 30 fragments, all of the same skull, about one-third of a mile down river from Bapang on the Tjemoro, in the area of the Sangiran dome. Here it was evident that the fossil skull (broken into pieces by the natives in order to make a dime for every single fragment: von Koenigswald, '47, p. 15)

came from the Kaboeh sandstones and conglomerates, the Trinil fauna, and not from older deposits (von Koenigswald, '38, p. 185).

The next *Pithecanthropus* skull find was made by Dr. Weidenreich during his visit to Java in 1938. In a case containing Trinil fossils that had been sent in from Sang'ran to the Bandoeng Museum, Dr. Weidenreich picked up some human-looking cranial fragments. As was the case with the mandible of 1936 the specimens were corroded and must have been exposed for a long time (*Pithecanthropus* III, von Koenigswald and Weidenreich, '38; von Koenigswald, '40, p. 102; Weidenreich, '45, p. 13-14). There seems to have been no consideration of doubt that this skull fragment really came from the Trinil (Kaboeh layers) fauna, although the circumstances of its discovery are the same as those of *Pithecanthropus* B two years earlier.

The year 1939 was the most successful of all. In January the collectors at Sangiran came across a palate with teeth embedded in a thick coating of matrix. Noticing that some breaks were fresh von Koenigswald, who was then about to leave Java for Peiping, instructed his collectors to look for more remains, and, sure enough, the posterior part of a skull (*Pithecanthropus* IV) turned up and was sent to von Koenigswald in Peiping (Weidenreich, '40, p. 34). As von Koenigswald ('40, p. 52; '47, p. 48) writes, these 1939 fossils come from the Lower Pleistocene layers of Sangiran, viz., the Poetjangan layers with Djetis fauna. The same would be true of the puzzling mandible fragment with M_1 and M_2 also discovered in 1939, now called *Pithecanthropus dubius* because of its doubtful position (von Koenigswald, '50b, p. 110).

The right mandibular ramus fragment that bears the name *Meganthropus palaeojavanicus* was sent to von Koenigswald from Sangiran in 1941, and a cast of this valuable specimen was sent along with that of the 1939 mandible to Weidenreich who was then already in New York. Although this was not explicitly stated in the accompanying letter by von Koenigswald to Weidenreich ('45, p. 16) it was claimed afterwards

by von Koenigswald ('47, p. 48; '50b, p. 107) that this 1941 fragment had likewise been found in the lower horizon at Sangiran, the Lower Pleistocene Djetis fauna.

Thus it has become evident that of these 6 recent Javan finds only the skull cap of 1937 (*Pithecanthropus* II) was made more or less in situ by Dr. von Koenigswald himself. And even this find of which we know the exact stratigraphic position is not definitely datable because of the alleged nature of the Trinil bone beds in which it was found.

Native collectors can certainly not be expected to know the differences between a Lower and a Middle Pleistocene fossil, but they will very probably tell what they know by previous experience the white man is pleased to hear. And it is very difficult sometimes to distinguish between Lower and Middle Pleistocene even for a professional geologist, as we have seen above.

THE AGE OF CERTAIN PLEISTOCENE VERTEBRATE FAUNAS IN ASIA

We may now ask ourselves why the Djetis fauna as such is early Pleistocene in age, and the Trinil fauna as such Middle Pleistocene.

The Djetis fauna is found in the Poetjangan layers of Java, and it has been the usage of the Geological Survey of the Dutch East Indies to regard these deposits as the base of the Pleistocene. The fauna of these beds can be correlated with other known fossil faunas elsewhere in Asia, more especially with those of the Upper Siwalik beds in the North of India. Von Koenigswald's first correlation was to the effect that he placed the Djetis fauna of Java as to age somewhere between the Pinjor and the Boulder conglomerate zones of the Siwalik series (von Koenigswald, '34, p. 200), but later it was decided that the Djetis fauna represented the same stage as the Pinjor (von Koenigswald, '40, p. 74; '50a, p. 93). The Pinjor zone fauna is of a characteristically Villafranchian type, characterized especially by the appearance of the first true elephant, *Archidiskodon planifrons*, which we find in many

places in Asia and which is used even in intercontinental correlations. Recently (1948) it has been internationally agreed upon that the Villafranchian marks the beginning of the Pleistocene; Dr. Colbert and I shall discuss the implications for Asia in a forthcoming paper. Dr. Teilhard de Chardin has always regarded it as more convenient, for China, to take the Villafranchian as Upper Pleistocene, and consequently he has regarded and still regards as Lower Pleistocene what we now place in the Middle Pleistocene (see, e.g., Teilhard de Chardin, '41, p. 44-45).

Now it is apparently a fact (see von Koenigswald, '40, p. 74; '50a, p. 92) that the typically Villafranchian genus *Archidiskodon* is already present in faunas in Java older than the Djetis fauna, viz., the Tjidjoelang and the Kali Glagah faunas which have always been placed in the Pliocene by von Koenigswald ('35a; '40, p. 74; '50a, p. 93-94). The correlations of the Tjidjoelang and the Kali Glagah faunas, however, are somewhat upset because of their Villafranchian aspect, and they should be placed in the Pleistocene too, as has already been realized by Colbert ('43, p. 426), Movius ('44, p. 84), and myself (Hooijer, '50, p. 37). This will permit the Djetis fauna to remain in the lower division of the Pleistocene, but it is quite evident that it is not exactly the lowermost of the Pleistocene faunas of Java. No finds of Early Man have been made as yet in the Tjidjoelang or the Kali Glagah fauna, which form the oldest Pleistocene faunas thus far known from the island of Java.

Von Koenigswald ('50a, p. 93), copied by Van Bemmelen ('50, p. 651), holds that a Pleistocene age cannot be accepted for the Tjidjoelang fauna since it occurs in a series of deposits which also contain the marine Cheribonian mollusk fauna of Oostingh "which by all standards is of Pliocene age" (von Koenigswald, '50a, l.c.). The Tjidjoelang fauna (which is older than that of the Kali Glagah) moreover possesses as "guide fossil" the genus *Merycopotamus*, which would be incompatible with a Pleistocene age (von Koenigswald, '50a, p. 93-94). *Merycopotamus*, however, is definitely known from

the Pinjor zone of the Siwaliks which is accepted even by von Koenigswald as being of Pleistocene age, and as far as the first argument is concerned I am authorized by Dr. Horace Richards of Philadelphia to state that the so-called Cheribonian fauna of Oostingh ('35) can be Quaternary in age as well. There is no good reason, Dr. Richards holds, to regard this special fauna as definitely Pliocene.

The modern trends in molluscan as well as vertebrate paleontology are to promote a certain unity of thought with regard to what should be the place of the Plio-Pleistocene boundary, and this was sanctioned at the last International Geological Congress held in London in 1948. Applied to the stratigraphy of Java, we have to accept that the boundary between Plio- and Pleistocene is right at the bottom of the Tjidjoelang fauna, with the first appearance of *Archidiskodon planifrons* (see table 1), comparable to the Tatrot zone fauna of the Siwaliks. This correlation is now widely accepted also by authors who are not in favor of a Pleistocene age of the Tatrot fauna.

The famous Trinil (Kaboeh) beds of Java are universally regarded as Middle Pleistocene in age. The typical development is at Trinil, where, as established by research of the Geological Survey, the underlying Poetjangan layers were left untouched by Dubois as well as by the Selenka Expedition members. The fauna is a definitely post-Villafranchian assemblage, with more advanced *Stegodon* as well as *Hippopotamus*. A number of Djétis genera such as *Epimachairodus*, "*Megacyon*," "*Cryptomastodon*," *Nestoritherium*, and *Leptobos* have not thus far turned up in the Geological Survey Trinil collections.

There would be nothing against *Nestoritherium* in the Middle Pleistocene, however, and in the Dubois Collection in Leyden we have the type specimens of *Leptobos groeneveldtii* (syn. *L. cosijni* v. K.), presumably from the Trinil conglomerates and tuffs. The stratigraphic position of these skulls may not be regarded as definitely settled, however.

It is becoming increasingly clear from detailed studies that the faunal distinctions in the Pleistocene of Java are not as sharp as they would seem to be from Dr. von Koenigswald's publications. Three examples may be mentioned here. A femur of *Rhinoceros unicornis kendengindicus* recently (Hooijer, '46, pp. 104-107) described from the Dubois collection is

TABLE 1
The Pleistocene mammalian faunas of Java

FAUNAL NAME	VON KOENIGSWALD		PRESENT AUTHOR
Ngandong	Upper	Pleistocene	Upper
Trinil	Middle		
Djetis	Lower		Middle
Kali Glagah	Upper	Pliocene	
Tjidjoelang	Middle		Lower
Tjisande ¹			

¹ The Tjisande fauna of von Koenigswald ('35a) comes from the Tjisande limestone in western Java, and it consists of just one tooth, viz., a battered rhinoceros molar baptized *Aceratherium boschi* by von Koenigswald. The specimen is so hopelessly defective that it may very well have belonged to the Pleistocene and still living *Rhinoceros sondaicus* of Java (Hooijer, '46, p. 107-108). Since the invertebrates indicate a Pliocene age (see van Bemmelen, '50, p. 650) this "fauna" may stay in the Pliocene; a Pontian age as has been assigned to it by von Koenigswald ('50a, p. 94), however, seems to be unjustified. I prefer to leave the Tjisande fauna as pre-Pleistocene without attempting to date it stratigraphically.

unmistakably from the Trinil site, while this special rhinoceros had authoritatively been excluded from the Middle Pleistocene by von Koenigswald ('34, p. 196) since it was not found in the Geological Survey collections from Trinil beds. The same is true for the giant pangolin, *Manis palaeojavanica*, a species that was believed by von Koenigswald to be confined to the Lower Pleistocene (von Koenigswald, '34, p. 190), but that recently was found to occur in the Tjitaroem valley fauna

(Hooijer, '47a) in association with *Bubalus palaeokerabau* which latter had never before been found in the Lower Pleistocene (see von Koenigswald, '40, p. 61). *Tapirus indicus*, supposedly extinct in Java since the Middle Pleistocene, proved to be represented in the Dubois collection from the Wadjak site, Central Java, which is late-, if not post-Pleistocene in age (Hooijer, '47b, p. 261). It would seem to be only logical to assume that, upon further accurate monographic studies of the various elements to the Pleistocene fauna of Java, the faunal differences between the Lower, Middle, and Upper divisions will dwindle more and more, and the picture of the evolution of the fauna will become less and less cataclysmic.

THE AGE OF EARLY MAN IN JAVA AND CHINA

The geologic age of Early Man in Java does not seem to be so very certain, after all that has been said about the faunas to which they belong. From the Middle Pleistocene Trinil beds, no matter what horizon they perhaps came from originally, we have the first skull cap of 1891 (*Pithecanthropus* I), the three dollar skull of 1937 (*Pithecanthropus* II), and, perhaps, also the cranial fragment of 1938 (*Pithecanthropus* III). The mandible fragment found by Dubois already as early as 1890 (*Pithecanthropus* A) originates from Kedoeng Broeboes, a locality about 25 miles away from Trinil. At Kedoeng Broeboes both the Poetjangan and the Kaboeh beds are exposed (von Koenigswald, '34, p. 188), so that there is no way of telling, again, whether the mandible fragment of 1890 is Early or Middle Pleistocene in age. However, there is another important find made by Dubois at the very same site, viz., the skeleton of *Manis palaeojavanica* (Dubois, '26). This species, as said above, is taken by von Koenigswald to belong to the Lower Pleistocene Dejtis fauna exclusively, and there is no obvious reason for not assigning the same age to the *Pithecanthropus* mandible except that the genus has also been found in the Middle Pleistocene. I think the chances are that Dubois must be given credit for having been the first to find *Pithecanthropus* in the Lower Pleistocene as well.

The remaining important finds, which are the more robust specimens (*Pithecanthropus* B, IV, and the 1939 and 1941 mandibles) may have originated from the Lower Pleistocene, and this would then fit in very nicely in Weidenreich's hypothesis that *Meganthropus* and *Pithecanthropus robustus* are ancestral to Middle Pleistocene *Pithecanthropus erectus*.

The age of *Gigantopithecus* is as uncertain as that of any find can be. The three molars (a 4th was found in 1939, but this is a badly worn lower molar with hardly anything of the crown surface left) were bought by von Koenigswald in drug stores in Hongkong. The associated fauna (*Hylobates*, *Pongo*, *Rhizomys*, *Cyon*, "*Ursus*," *Ailuropoda*, *Arctonyx*, *Stegodon*, and *Tapirus* [*Megatapirus*], see von Koenigswald, '35b) strongly suggests the so-called *Stegodon-Ailuropoda* fauna from southern China. This fauna, which will be fully described in a forthcoming memoir by Dr. E. H. Colbert and myself, belongs to a complex of faunas that includes the Trinil fauna of Java and is definitely early post-Villafranchian. Therefore, a Middle Pleistocene age can best be ascribed to it (Colbert, '42, p. 6-7). The *Stegodon-Ailuropoda* fauna is now known from China south of the Tsinling dividing range, as well as from Indo China, Upper Burma, and Java. Though *Gigantopithecus* has not yet been found to occur in situ at any of the *Stegodon-Ailuropoda* sites in the Far East it is generally accepted now as belonging to that fauna (Teilhard de Chardin, '41, p. 25). The age of *Gigantopithecus* would thus be Middle Pleistocene, geologically too young, perhaps, for consideration as an ancestral form of *Pithecanthropus* if *Gigantopithecus* is anatomically fit at all for this hypothesis, which seems to be highly improbable (cf. Hooton, '47, p. 421; Hooijer, '49, p. 513; Remane, '50, and Ashton and Zuckerman, '50).

As stated already in earlier papers (Hooijer, '47c, '48, p. 292; '49) its gigantic size is not necessarily an objection against *Gigantopithecus* being the ancestor of *Pithecanthropus*, although the difference in size is rather large and it is more probable that *Gigantopithecus* represents an extinct side branch of the evolutionary tree of the Primates.

Pekin Man, "*Sinanthropus pekinensis*," the earliest fossil human type in China, well represented and magnificently described, also belongs in the Middle Pleistocene. The fauna to which Pekin Man belongs (and the association is beyond any doubt) is typically early post-Villafranchian (Teilhard de Chardin, '41, p. 86). Pekin Man comes, however, from Choukoutien, near Peiping, far north of the main Tsinling Range, which separates two different post-Villafranchian faunal assemblages, that to the north having Eurasiatic, and that to the south Indo-Malayan affinities. Age correlations, therefore, are necessarily vague only. Pekin Man is looked upon as an immigrant from the South-Tsinling area, and the water buffalo apparently came with him to the north of China. There is no way of telling whether Pekin Man was living in the Choukoutien area, at his fireplace and workshop, at exactly the same time when Trinil Man struggled along the Solo river banks in Central and Eastern Java. Most probably he was not. Anatomically, Pekin Man is only a subspecies (*Pithecanthropus erectus pekinensis*) of Trinil Man; the fact that they were most probably not of exactly the same age is no objection to this since the races of a species replace each other in geologic time as well as geographically. And we have also Pleistocene carnivore and ungulate species with subspecies in Java as well as in North China.

A few words, finally, about the Pleistocene climatic sequence and the recent trend to assign certain fossil faunas as well as Paleolithic cultures to Lower, Middle, or Upper Pleistocene in terms of the fourfold glacial cycle in the Indian region. It would seem that in Java and in China the geological evidence of there having been four glaciations is far from conclusive and that it is not well possible to link any given erosional cycle or river terrace succession with the alleged glacial sequence in the Pleistocene. Van Bemmelen ('50, p. 96) has, I think, raised very serious objections against this correlation method by pointing out that in Java, at least, we have evidence of Quaternary and Late Tertiary epeirogenic movements (uplifts as well as downwarps) in the order of magnitude of

several thousand feet, while the eustatic oscillations of the sea level amount only to a few hundred feet at most. Thus, it seems that in Java this method of Pleistocene chronology fails. The method has certainly part of the truth, but in Java it is completely overshadowed by the epeirogenic movements of much greater magnitude.

SUMMARY AND CONCLUSIONS

All of the famous finds of Early Man in Java between 1936 and 1941 were made by natives, and more than once their true nature was only discovered after the specimen had reached the Geological Survey Museum at Bandoeng in Western Java. It is evident that it is not easily possible to determine the age of a fossil from the matrix that may still stick to it, or else from native reports as to where exactly it was found. Furthermore von Koenigswald and de Terra have expressed opinions about the nature of the Trinil bone beds that make it possible for a fossil from these beds to be of any age in and even after the Pleistocene.

The so-called Djetis fauna of Java with "*Homo*" *modjokertensis* is not the oldest Pleistocene fauna in Java; it is preceded by the Tjidjoelang and Kali Glagah faunas which also deserve a place in the Lower Pleistocene.

The finds of Early Man in Java, therefore, cannot be exactly dated, and the only thing we can honestly say is that they are Pleistocene in age, and most probably neither lowermost nor late Pleistocene. There is some evidence that the more robust types, as well as, perhaps, the mandible found as early as 1890 by Dubois, came from the Djetis beds, somewhere in the Lower Pleistocene. The Modjokerto infant skull is from the Djetis beds, while typical *Pithecanthropus erectus* is from the Trinil beds.

The faunal distinctions between the Djetis and the Trinil beds are dwindling, and I can see the possibility that, with future increase of our knowledge of the Pleistocene faunas of Java, we shall have a much less cataclysmic picture of the faunal evolution.

The age of *Gigantopithecus* is as uncertain as any, but the chances are that it belongs to the Middle Pleistocene *Stegodon-Ailuropoda* faunal complex which means that this giant may sometime be found in Java too.

"*Sinanthropus*" seems to be roughly contemporaneous with *Pithecanthropus erectus*: Middle Pleistocene. Middle Pleistocene stands, however, only for early post-Villafranchian, the Villafranchian being internationally agreed upon to be Lower Pleistocene. An exact correlation method to the effect that Trinil and Choukoutien belong to one and the same stage in the glacial cycle, in my opinion, is completely unjustified. Epeirogenic movements of very great magnitude that have taken place during the period here involved completely overshadow the comparatively slight effects which eustatic oscillations of the sea level may have had on the nature of the sediments or on the present altitude of river terraces on which these correlations have recently been based.

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NEW FRENCH PUBLICATIONS.—The following articles of interest to physical anthropology have been published recently in the *Bulletins et Mémoires de la Société d'Anthropologie*. This listing is a continuation of that begun in the December, 1947, issue (this Journal, n.s. vol. 5, no. 4, pp. 433-434.)

9^e série, tome 7^e, fasc. 4-6, for 1946 (1947):

- Beauvieux, J. Essai d'une systématisation anthropologique et comparative de l'architecture cranio-faciale. pp. 105-139.
- Giot, P. R. L'anthropologie pre- et protohistorique de Finistère. pp. 140-156.
- Pales, L. Les variations de fréquence du muscle petit palmaire (*M. palmaris longus*) dans les races humaines: essai de mise au point de la question. pp. 157-184.
- Solas, L. Rationalisation de la nomenclature anatomique, surtout en anthropologie. pp. 185-200.

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- Falkenburger, F. Le rôle de l'anthropologie dans l'enseignement universitaire et scolaire. pp. 63-67.
- Gebara, I. Sur quelques indices de longueur et de largeur des mandibules humaines. pp. 55-62.
- Gessain, R. Observations morpho-physiologiques sur des Italiens. pp. 80-84.
- Glory, A., and R. Robert Le culte des crânes humains aux époques préhistoriques. pp. 114-133.
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- Olivier, G. Contribution à l'étude anthropologique du Sud-Cameroun. pp. 68-75.
- Pales, L., and Chippaux Étude comparative de l'innervation superficielle de la jambe et du dos du pied chez les Blancs et chez les Noirs soudanais occidentaux. pp. 85-113.
- Royer, R. Crâne cromagnon dans le département du Gard. pp. 76-79.
- Tisserand, M. Appréciation de la pigmentation dans la population française. I. Présentation de deux échelles chromatiques destinées aux recherches sur la pigmentation des yeux et des cheveux. pp. 24-37.
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- Delattre, A., and J. M. Daele. Le mécanisme de la transformation du crâne animal en crâne humain. pp. 12-32.
- Frassetto, F. Sur une nouvelle classification des races humaines fossiles selon la théorie du digénisme. pp. 62-70.
- Khérumian, R. Note sur la longueur de pénis des habitants de l'Europe centrale. pp. 138-142.
- Koerber, R. Contribution à l'étude de la répartition des groupes sanguins chez quelques races de l'Afrique occidentale française. pp. 167-172.
- Lalouel, J. Les variations de fréquence du muscle petit palmaire chez les Noirs et les Négrilles. pp. 163-166.
- Leschi, J. Empreintes digitales chez quelques peuples d'Afrique occidentale française. pp. 143-150.
- Stature et croissance chez des Oulof d'Afrique occidentale française. pp. 173-176.
- Marquié, M. Les populations énéolithiques de l'Aveyron. pp. 108-126.
- Olivier, G. Contribution à l'étude anthropologique des Bamoun. pp. 151-162.
- Papamiltiadès, M. Observations sur la fréquence d'un faisceau surnuméraire du muscle pédieux chez les Grecs. pp. 177-179.
- Poulhès, J. La branche ischio-pubienne; ses caractères sexuels. pp. 191-201.
- Riquet A propos de deux crânes néolithiques de l'Ouest. pp. 71-86.
- Vassal, P. Observations ethnographiques et anthropologiques sur les Lapons de Norvège. pp. 33-61.

RECENT ITALIAN PUBLICATIONS.—The following papers of interest to physical anthropologists are contained in the *Rivista di Antropologia*, vol. 37 for 1949, which appeared recently:

Correnti, Venerando. Il metodo degli auxogrammi	46-89
Maxia, Carlo. Antropologia dell'uomo sardo attuale	90-125
Correnti, Venerando. Correlazioni morfofisiologiche di alcune dimensioni del torace. Osservazioni sulle escursioni respiratorie del torace, rilevate con l'indagine radiologica	126-142
Ascenzi, Antonio. Prime osservazioni con il microscopio elettronico su ossa fossili (Cranio del secondo paleantropo di Saccopastore e cranio di <i>Elephas antiquus</i>)	143-148
Castellano, Vittorio. Osservazioni preliminari su alcuni risultati del censimento della popolazione indigena della Eritrea del 1939	149-154
Sergi, Sergio. L'occhio berbero. Un particolare carattere della palpebra superiore nell'occhio dei Tuaregh	155-162
Cappieri, Mario. Contributo alla antropologia dei bengalisi	163-176
Sergi, Sergio. Pantogoniostato craniosteofo e assidiatero. Le posizioni del cranio e delle ossa per la tecnica craniografica ed osteografica	189-218

SOME CRANIAL INDICES OF PLESIANTHROPUS AND OTHER PRIMATES

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TWO FIGURES

INTRODUCTION

The skull of the Australopithecinae is said to differ from that of the living apes in the lowness of the nuchal ridges, in the higher "set" of the braincase, and in the forward position of the occipital condyles. Le Gros Clark ('50) has recently attempted to express these characteristics quantitatively in terms of three indices derived from measurements taken from photographs of the norma lateralis of the skull. He treats the values of these indices as derived from a photograph of *Plesianthropus* 5, a presumed middle-aged or elderly female (Broom, Robinson and Schepers, '50), as characteristic of the Australopithecinae in general. This skull was embedded in lime and during the process of recovery was broken in two by a fracture through the widest part of the braincase. The cranial cavity was lined with crystalline lime. The skull is said to have been "scarcely crushed at all" during the process of fossilization (Broom, '50).

Le Gros Clark has compared the values of the three cranial indices of *Plesianthropus* 5 with the corresponding figures for 90 skulls of adult chimpanzees, gorillas and orang-outans of both sexes. He concludes that they "appear definitely to place the australopithecine skull outside the limits of variation of the large anthropoid apes, and to indicate a rather remarkable approximation to the hominid skull."

In view of the fact that no figures are given for the corresponding indices in man or for species of primate other than

the Pongidae, the further comparisons reported in the present paper were made, based upon statistical methods.

MATERIAL AND METHODS

Skulls. A list of the skulls studied is given in table 1. Attention was confined to adult skulls in which, as in *Plesianthropus* 5, all the permanent teeth had erupted. Where marked sexual dimorphism existed in the species studied (e.g. most Old World Monkeys and great apes) the samples were arranged so as to include approximately equal numbers of males and females, since the sex of *Plesianthropus* 5 cannot be diagnosed with complete certainty. Otherwise (e.g. gibbons and New World Monkeys) adult skulls were taken at random from the museum collections.

Indices of modern primates. The indices used in this study are illustrated in figure 1. The index AG/AB gives a measure of the height to which the nuchal musculature extends above the Frankfort plane (EACD) in relation to the total height of the skull above this plane: index FB/AB indicates the proportion of the braincase above the upper orbital margin relative to the total height above the Frankfort horizontal; CD/CE indicates the position of the occipital condyles.

Measurement. The skull was fixed on its side in the cranio-stat described by Ashton and Pardoe ('50). The positions of the prosthion; the highest point of the superior nuchal line; and the upper and lower orbital margins were marked by means of the projector on an underlying sheet of cartridge paper. Because of the arched formation of the nuchal lines in many skulls of great apes and men, the maximum height of the nuchal crest does not always correspond with that of the inion. Series of points in the mid-sagittal line of the skull, and approximately one-tenth of an inch apart, were transferred to the paper so as to define the highest part of the vault, the most posterior region of the occiput and the position of the occipital condyles. The points were then joined by smooth curves. The line joining the projection of the lowest point of the inferior orbital margin to the upper border

of the hole through which the lower spike of the craniometer passed is the Frankfort horizontal. The diameters necessary to compute the three indices were then drawn directly with a parallel rule and set-square. Measurements were taken with a steel scale and recorded to the nearest millimeter.

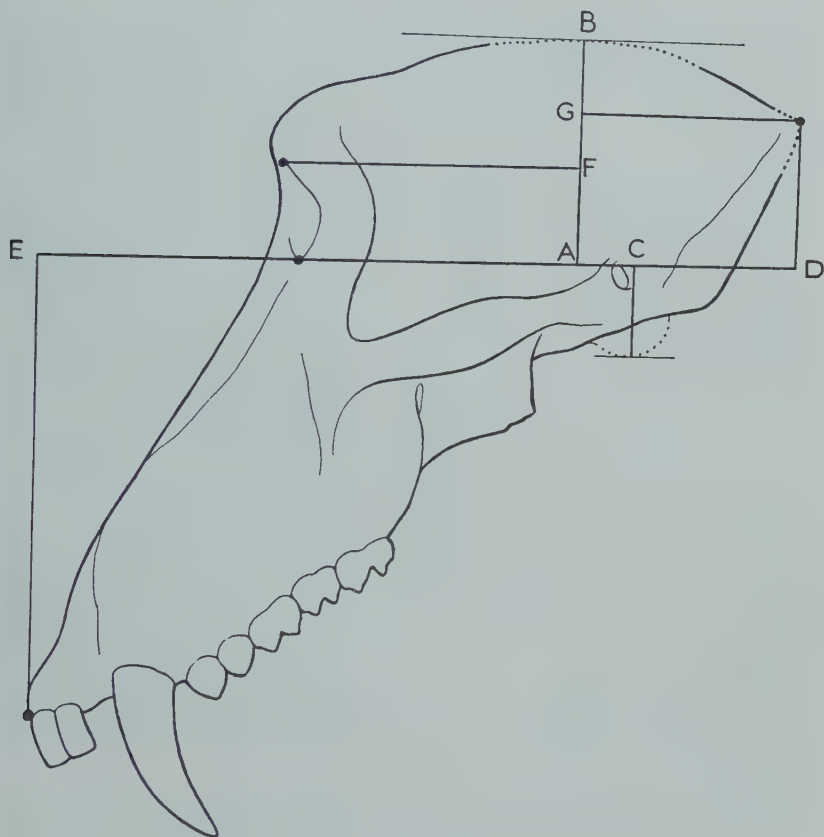


Fig. 1 Profile outline of skull of adult male baboon.

E A C D = Frankfort plane (= horizontal).

A B = Height of vault above Frankfort plane.

A G = Height of nuchal musculature above Frankfort plane.

F B = Height of vault above upper orbital margin.

C = Position of lowest point of occipital condyle relative to E D, maximum projection of skull in Frankfort plane.

The parts of the contour of the skull indicated by the interrupted line were those marked by means of the craniostat on the paper. The other points marked were those indicated by large black dots.

Indices of Plesianthropus 5. We have re-measured the photographs published by Le Gros Clark ('50) and by Broom, Robinson and Schepers ('50), and have confirmed the values of the three indices as given by Le Gros Clark.

TABLE 1
The numbers and location of primate skulls studied

	NO. OF SKULLS EXAMINED	LOCATION
<i>Hominidae</i>		
<i>Homo sapiens</i>		
British (Spitalfields)	30	Cambridge University Museum of Archaeology and Ethnology.
West African negro	29	British Museum (Natural History).
Australian aboriginal	28	British Museum (Natural History).
<i>Ponginae</i>		
<i>Gorilla gorilla</i> , gorilla	59	29 British Museum (Natural History). 30 Royal College of Surgeons. 30 Powell-Cotton Museum.
<i>Pan</i> sp., chimpanzee	56	26 British Museum (Natural History). 30 Royal College of Surgeons. 30 Powell-Cotton Museum.
<i>Pongo pygmaeus</i> , orang-outan	25	British Museum (Natural History). Royal College of Surgeons.
<i>Hylobatinae</i>		
<i>Hylobates</i> sp., gibbon	31	British Museum (Natural History).
<i>Symphalangus</i> sp., siamang	12	British Museum (Natural History).
<i>Cercopithecinae</i>		
<i>Cercopithecus grayi</i> , Gray's monkey	30	Powell-Cotton Museum.
<i>Papio porcarius</i> , baboon	27	British Museum (Natural History). S.Z. private collection.
<i>Colobinae</i>		
<i>Colobus satanas</i> , black guereza	30	Powell-Cotton Museum.
<i>Atelinae</i>		
<i>Ateles</i> sp., spider monkey	19	British Museum (Natural History).
<i>Lagothrix</i> sp., woolly monkey	20	British Museum (Natural History).

Tests of technique. A sample of 6 female chimpanzees from the Powell-Cotton Museum was selected because of their similarity in general size and shape. Each was measured 6 times in the craniostat, 5 sets of measurements being taken 6 months after the first. Analyses of the data showed that the variance due to differences in the 6 sets of measurements for each skull was insignificant ($P < 0.001$) compared with that existing between the skulls. It is to be expected that variation in an unselected series of skulls would be greater than that in the 6 chosen because of their general similarity in size and shape. It is highly improbable, therefore, that inaccuracies of measurement have affected the results reported below.

On the other hand, it is necessary to note that the values of the indices as derived from photographs are consistently different from those provided by measurements of the skulls themselves. A test was made on 58 specimens of gorilla and chimpanzee.¹ In 51 of the 58 comparisons the values for the index FB/AB based on measurements of the skull were greater than the corresponding ones derived from photographs. In 3 they were smaller and in 4 equal. On an average the directly determined index was 8.4% greater than that derived from the photographs. Statistical tests showed that the difference was significant.

Corresponding comparisons showed that the index AG/AB was almost always greater (mean 4.1%) when measured directly from the skull than from photographs. The difference was again statistically significant. The trend of the index CD/CE was, however, in the opposite direction, in so far as the photographic value was almost always greater (mean 3.8%) than the value determined directly from the skull. Again the difference was significant statistically.

¹ Photographs were made with a Leica, lens focal length 5 cm, the camera being held at a fixed distance about $4\frac{1}{2}$ feet from the skull. Measurements were made on prints; the paper was tested for shrinkage, which never amounted to as much as 1%.

It is a reasonable assumption that the indices derived from a photograph of *Plesianthropus* 5 are correspondingly divergent from those which would be given by measurements of the skull itself. The photographic values have accordingly been corrected by the average ratios of distortion revealed by our comparison of actual skulls and their photographs, in order to derive a second set of estimates for the indices of *Plesianthropus* 5. Our measurements of chimpanzee and gorilla skulls from the Powell-Cotton Museum were compared with those from the Royal College of Surgeons and the British Museum of Natural History. There were no statistically significant differences ($P > 0.05$). When allowance was made for photographic distortion, the mean values for the chimpanzee and gorilla as given by Le Gros Clark ('50) were also found not to differ markedly from our own figures, except in the case of the index AG/AB for the chimpanzee. Here our own means are between 7 and 10 units greater.

STATISTICAL ANALYSIS

Basic data. The mean, standard deviation and the standard error of the mean of each index for each type of Primate were computed by standard methods (Fisher, '46). The mean index AG/AB for each of the three types of man was very small (-0.57 to $+4.52$). Except for this and two other isolated instances out of 45 (three indices in each of 15 groups), the standard error of the mean proved to be less than 5% of the mean itself. Our estimates of the means and variances may consequently be regarded as reliable. The data are presented in table 2.

Comparison with Plesianthropus 5. The corrected and uncorrected indices of *Plesianthropus* 5 were separately compared with each type of monkey, ape and man, by means of *t* tests. The results are summarized in table 3 and figure 2.

RESULTS

At the level of $P \leq 0.02$ the index AG/AB of *Plesianthropus* 5 as given by Le Gros Clark agrees with the three types of

TABLE 2

Cranial indices of living Primates

	100 AG/AB			100 FB/AB			100 CD/CE					
	MEAN	NO. OF OBSER- VATIONS	STAND- ARD DEVI- ATION	STANDARD ERROR OF MEAN	MEAN	NO. OF OBSER- VATIONS	STAND- ARD DEVI- ATION	STANDARD ERROR OF MEAN	MEAN	NO. OF OBSER- VATIONS	STAND- ARD DEVI- ATION	STANDARD ERROR OF MEAN
Englishman (Spitalfields)	— 0.57	30	6.22	1.14	71.30	30	2.00	0.37	81.27	30	9.32	1.70
West African	+ 4.52	29	5.00	0.93	70.41	29	2.03	0.38	76.97	29	6.98	1.30
Australian	+ 3.39	28	8.83	1.67	70.57	28	2.69	0.51	78.25	28	6.54	1.24
Gorilla (B.M.N.H. and R.C.S.)	76.83	29	11.38	2.11	51.79	29	6.75	1.25	26.07	29	7.45	1.38
Gorilla (P.C.M.)	71.00	30	11.52	2.10	54.03	30	8.18	1.49	27.50	30	6.28	1.15
Chimpanzee (B.M.N.H. and R.C.S.)	50.81	26	6.96	1.37	49.77	26	4.68	0.92	24.96	26	4.03	0.79
Chimpanzee (P.C.M.)	53.30	30	6.19	1.13	50.80	30	3.43	0.63	23.62	29	3.40	0.63
Orang-outan	64.72	25	7.07	1.42	49.24	25	5.60	1.12	21.64	25	3.87	0.77
Gibbon	38.74	31	6.56	1.18	47.06	31	3.51	0.63	25.74	31	4.99	0.90
Siamang	47.67	12	8.03	2.32	47.00	12	3.59	1.04	21.58	12	5.16	1.49
Baboon (<i>Papio porcarius</i>)	55.59	27	8.60	1.66	50.52	27	3.17	0.61	26.81	27	3.64	0.70
<i>Cercopithecus grayi</i>	36.30	30	9.56	1.75	43.57	30	3.55	0.65	28.43	30	3.41	0.62
<i>Colobus satanas</i>	47.90	30	6.19	1.13	41.73	30	4.08	0.74	21.97	30	2.92	0.53
Spider mmokey	38.42	19	9.62	2.21	51.58	19	3.44	0.79	29.32	19	2.87	0.66
Woolly monkey	52.35	20	7.76	1.73	47.75	20	3.25	0.73	21.65	20	4.19	0.94

TABLE 3

Comparison between cranial indices of Plesianthropus 5 and those of living Primates: values of P for t tests
 ("+" indicates that the value for Plesianthropus is bigger, and "-" smaller, than in the living Primates with which it is compared.)

	VALUES OF PLESIANTHROPUS GIVEN BY LE GEOS CLARK				VALUES FOR PLESIANTHROPUS CORRECTED FOR PHOTOGRAPHIC DISTORTION			
	100 AG/AB	100 FB/AB	100 CD/CE		100 AG/AB	100 FB/AB	100 CD/CE	
<i>Plesianthropus</i> indices	8	68	40		8	74	39	
Englishman (Spitalfields)	0.2-0.1	0.2-0.1	0.001 -		0.2-0.1	0.2-0.1	0.001 -	
West African	0.5-0.4	0.3-0.2	0.001 -		0.5-0.4	0.1-0.05	0.001 -	
Australian	0.7-0.6	0.4-0.3	0.001 -		0.7-0.6	0.3-0.2	0.001 -	
Gorilla (B.M.N.H. and R.C.S.)	0.001 -	0.05-0.02	0.1-0.05		0.001 -	0.01-0.001 +	0.1-0.05	
Gorilla (P.C.M.)	0.001 -	0.1 -0.05	0.1-0.05		0.001 -	0.05-0.02	0.1-0.05	
Chimpanzee (B.M.N.H. and R.C.S.)	0.001 -	0.001 +	0.001 +		0.001 -	0.001 +	0.01-0.001 +	
Chimpanzee (P.C.M.)	0.001 -	0.001 +	0.001 +		0.001 -	0.001 +	0.001 +	
Orang-outan	0.001 -	0.01-0.001 +	0.001 +		0.001 -	0.001 +	0.001 +	
Gibbon	0.001 -	0.001 +	0.01-0.001 +		0.001 -	0.001 +	0.02-0.01 +	
Siamang	0.001 -	0.001 +	0.01-0.001 +		0.001 -	0.001 +	0.01-0.001 +	
Baboon (<i>Papio porcarius</i>)	0.001 -	0.001 +	0.01-0.001 +		0.001 -	0.001 +	0.01-0.001 +	
<i>Cercopithecus gracy</i>	0.01-0.001 -	0.001 +	0.01-0.001 +		0.01-0.001 -	0.001 +	0.01-0.001 +	
<i>Colobus satanas</i>	0.001 -	0.001 +	0.001 +		0.001 -	0.001 +	0.001 +	
Spider monkey	0.01-0.001 -	0.001 +	0.01-0.001 +		0.01-0.001 -	0.001 +	0.01-0.001 +	
Woolly monkey	0.001 -	0.001 +	0.001 -		0.001 -	0.001 +	0.001 +	

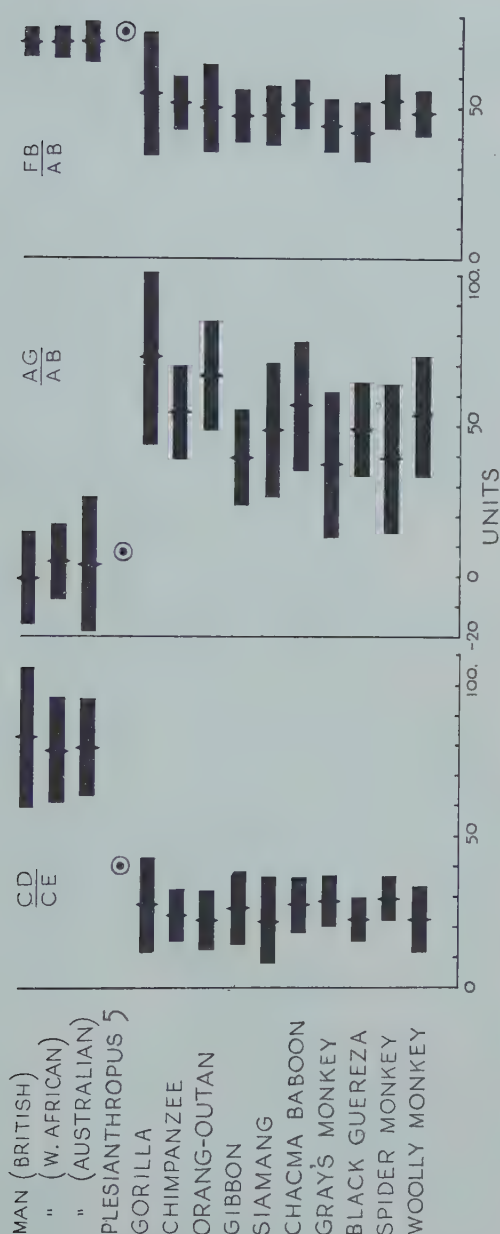


Fig. 2 The relationship of the condylar position index (CD/CE), the nuchal height index (AG/AB), and the supra-orbital height index (FB/AB), of Plesianthropus, to that of man, apes and monkeys.

man, and is significantly smaller than in the other types of Primate. The index FB/AB agrees with each type of man and with the gorilla, but is significantly greater than in the other types of Primates studied. CD/CF agrees with the gorilla, but is significantly smaller than in the three types of man, and significantly bigger than in the other apes and monkeys measured.

When the quoted indices for *Plesianthropus* 5 are corrected for photographic distortion, and the new values compared, the results remain the same except in the case of the index FB/AB whose revised value is significantly greater at a level of $P \leq 0.02$ than in the sample of gorillas from the Royal College of Surgeons and the British Museum. At this level of significance, however, it still does not deviate from the sample of gorillas from the Powell-Cotton Museum.

DISCUSSION

The present study confirms Le Gros Clark's observation that the index AG/AB (nuchal-area height index) is significantly smaller in *Plesianthropus* 5 than in the great apes, and that it agrees with the human value. The index FB/AB (supraorbital height index) also agrees in magnitude with that of man and, except for the gorilla, surpasses the range of variability of the subhuman Primates studied. It should, however, be observed that comparison with the gorilla may be somewhat misleading. *Plesianthropus* 5 did not possess a sagittal crest, whereas this structure, which will tend to increase the absolute value of the index, is almost always present in the adult male gorilla, and is sometimes present in the female.

Fifteen of the gorilla skulls studied had a supraorbital height index which either equalled or exceeded the maximum figure for a gorilla as recorded by Le Gros Clark; one of these was 66, and two 67, as compared with a value of 68 for *Plesianthropus* 5. In spite of the shortcoming which the existence of a sagittal crest imposes on the comparison, the single value for *Plesianthropus* is thus in any event near the

upper limit of variability for the gorilla. Moreover, when the *Plesianthropus* value is corrected for photographic distortion, it diverges significantly from the sample of gorillas from the London Museums — although it still agrees, at a significance level of $P \leq 0.02$, with the sample from the Powell-Cotton Museum. It is, of course, conceivable that the high value of the index of *Plesianthropus* 5 is due, in some measure, to antero-posterior compression during fossilization.

The “condylar position” index of *Plesianthropus* 5 does not diverge in a statistically significant manner from that of the gorilla, but differs from man and the other Primates. Le Gros Clark has observed that the value given for *Plesianthropus* 5 (40) was equalled by only one gorilla “of very unusual (? abnormal) shape in the British Museum collection (B.M. 23. 11. 29. 5).” In the series of 59 gorilla specimens which we have examined in the present study, this extreme value was exceeded by two other skulls (Powell-Cotton Museum, M.503, and British Museum 23. 11. 29. 6.). In two others (Powell-Cotton Museum, M.264, and British Museum 29. 1. 1.), the index reached the value of 40 quoted for *Plesianthropus* 5. As this index is a measure of the balance of the entire skull relative to the carriage of the body, it seems immaterial whether the post-condylar segment is composed entirely of braincase, or whether it is prolonged by an occipital crest, as is usual in the male gorilla. If *Plesianthropus* did in fact walk upright, the only conclusion one can draw from our figures is that its skull was not balanced like the human skull.

Le Gros Clark remarks that “In so far as these indices may be related to a common factor — the poise of the head in relation to the vertebral column — it is particularly interesting to note that, taken in combination, they appear definitely to place the australopithecine skull outside the limits of variation of the large anthropoid apes, and to indicate a rather remarkable approximation to the hominid skull.” Whether these three indices are in fact “related to a common factor” is, however, questionable. Schultz ('42) has shown

that the amount of nuchal musculature necessary to "balance" the head is relatively less in man than in other Primates; it would seem, therefore, that a high value for the "condylar position" index may be associated with a relatively small area of attachment for the nuchal musculature. This, on the other hand, is not necessarily associated with a low "nuchal height" index in so far as the height of the nuchal area will partly depend on the relative degree and kind of expansion of the brain-case.

The fact that the three indices are not significantly correlated was established in a statistical analysis of the extent of the correlation of 6 types of Primates selected at random from the series studied. Of 18 correlations tested only two were statistically significant, the exceptional two being one pair of indices in the gorilla, and one in *Cercopithecus grayi*. Fifteen of the 18 correlations gave values of r less than 0.5. This result, together with the observation that the three indices in *Plesianthropus* do not diverge from the great apes and monkeys on the one hand and from man on the other, either in the same direction or to the same relative extent, suggests that they may not, contrary to Le Gros Clark's suggestion, be related to a single morphogenetic factor.

It should be noted that the three indices do not have an equal value in defining cranial characteristics. The fact that both FB and AG are highly correlated with AB considerably limits the amount of useful information the indices FB/AB and AG/AB provide about the expansion of the cranial vault, and about the height to which the nuchal musculature reaches. CD, on the other hand, is not necessarily correlated with CE, and does not therefore suffer from a corresponding shortcoming.

We are much indebted to Mr. T. C. S. Morrison-Scott and Dr. F. C. Fraser of the British Museum of Natural History, London, to Mrs. H. B. Powell-Cotton of the Powell-Cotton Museum, Birchington, and to Dr. J. C. Trevor of the Cam-

bridge University Museum of Archaeology and Ethnology, for allowing us to study the collections of skulls in their charge. Expenses incurred in the computing were met by a grant from the Royal Society; those incurred in the "field-work" were met by a grant from the Wenner-Gren Foundation, U.S.A. Our best thanks are also due to Mr. W. J. Pardoe for preparing the photographs used in this study.

SUMMARY

1. Three cranial indices of the norma lateralis of the skull, when orientated in the Frankfort plane, have been defined to express: (a) the height to which the nuchal musculature extends above the Frankfort plane relative to the total height of the skull above that plane, (b) the height to which the cranial vault extends above the upper orbital margin relative to the total height of the skull above the Frankfort plane, (c) the position of the occipital condyles relative to the anterior and posterior limits of the skull.

2. The mean value and variances of these indices have been established in three types of modern man; in three great apes; in three species of Old World monkey; and in two species of New World monkey. These have been compared by appropriate statistical methods with the corresponding indices of the australopithecine skull "*Plesianthropus* 5."

3. The relative height to which the nuchal musculature of *Plesianthropus* 5 extends is the same as in man, and is less than in the subhuman Primates studied. The proportion of the cranium above the upper orbital margin is the same as in man and the gorilla, but is greater than in the other primate types studied. The occipital condyles are relatively more posterior in *Plesianthropus* 5 than in man and, with the exception of the gorilla, more anterior than in the subhuman primate types studied. Their position agrees with that in the gorilla.

4. The three indices are not highly correlated, and it is unlikely that they all depend on a single morphogenetic factor — e.g. posture.

5. If *Plesianthropus* did in fact walk upright its head was not balanced as in modern man.

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CORRIGENDUM

In "The Walbrook frontal bone," by M. F. Ashley Montagu, in this journal, vol. 9, no. 1, p. 13, the sentence which now begins with the word "Elephas" should read as follows:

"Rhinoceros bone from the same clay bed showed a fluorine content of 1.1%, while *Elephas* from the sand showed a fluorine content of 1.3%."

STUDIES IN ANTHROPOMETRY OF JEWISH INFANTS IN PALESTINE

I. WEIGHT OF THE NEWBORN

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INTRODUCTION

To a student of anthropometrics the Jewish people are of extraordinary interest. As a racial type the Jews were originally homogeneous and because of religious prohibitions and their intensely exclusive national way of life, the admixture of outsiders has been kept to a minimum. On the other hand, for almost two thousand years the Jews have been dispersed all over the world and influenced accordingly by different climates, environments, foods, etc. Jews generally can be regarded as interesting material from the anthropological and ethnological point of view, and Palestine, because of the Zionist renaissance, has now become a demographical melting-pot of all types of Jews. The Jewish population of Palestine, approximately 600,000 up to the establishment of the State of Israel, consists of representatives of Jews from practically every country in the world.

Nevertheless, Jewish anthropology in general, and differential anthropology in particular, has not yet been sufficiently elaborated; mention will be made in the course of this paper of the few studies that have been conducted. The object of this paper is to present some basic data on the anthropology of Jewish newborns. We have based this survey on data collected from the medical records of infants born in the Maternity Department of the Rothschild-Hadassah University Hospital¹ during the years 1940-45.

¹ The authors wish to thank Prof. Bernard Zondek, Head of the Maternity Department of the Rothschild Hadassah University Hospital, for his kind permission to use the records of the Department.

The weight of 2500 gm is generally considered a limit for a mature infant. In one of the recent publications on the subject (Dunham, '48) we found a resolution adopted by the American Academy of Pediatrics that "a premature infant is one who weighs 2500 gm or less at birth regardless of the period of gestation." However, since one of our purposes was comparison between the different Jewish communities, we included in part of the tables all aliveborn infants even if their weight was considerably less than 2500 gm. The statistical material in this paper is therefore mainly based on our total "population" and only partly on that of infants weighing 2500 gm and over. When examining the figures we shall see that there are differences between the various communities of the Jewish population, and it would be for anthropologists to decide whether there is any justification in fixing a different limit of maturity for each community. The material was limited to live single births only. In this way, a total of about 8500 infants came under review. There are some fluctuations in the number of observations in different tables because some records were deficient and could not be used in all classifications and distributions.

The material was divided into four main communities. This division is familiar to all students of the demographical problems of the Jews. The four communities are:

(a) Ashkenazi Jews, i.e., Jews of European descent. Although in certain demographical features there are differences between Eastern European and Western European Jews, we do not believe that they influence their anthropometry.

(b) Sephardic Jews, i.e., Spanish Jews. This group, originating in Medieval Spain under the rule of the Moors, now comprises the Jews of North Africa, Southern Europe (Italy, Greece, Bulgaria, Yugoslavia), the indigenous Jewish population of Palestine, and small groups elsewhere (Holland, the Portugese community in England and U.S.A.).

(c) Oriental Jews, including countries east of Palestine (Persia, Iraq, Syria, Afganistan, Georgia, etc.). In order

to get a sufficiently large number of observations in each group we found it was not practicable to subdivide these communities.

(d) Yemenite Jews. This is a very definite and separate group historically, demographically and ethnographically, and is of great interest. However, since the group was very small numerically in our material and part of our cards (those of infants weighing less than 2500 gm) was lost due to the war conditions in Israel and the evacuation of our permanent premises on Mt. Scopus, we omitted it altogether in our discussions. We shall try to collect separately a sufficient number of observations on Yemenites to present it to those concerned.

The present section of our study deals with weight at birth. However, the material collected offers an opportunity of clarifying many other problems which will be presented in due course.

MATERIAL AND RESULTS

Each infant delivered is weighed immediately after delivery and the weight in grams (to the nearest 5 gm) is registered on its chart. During the 7 days of the infant's normal stay in the hospital, it is weighed daily. Only the weight at birth will now be taken into consideration.

Table 1 presents the distribution of the infants of each community according to weight-groups of 250 gm. The volume of our material and its division by communities will be seen from the table.

About 5% of the infants were in the weight group under 2500 gm. There are variations between the communities: the percentage is lowest among the Ashkenazi infants (4.60%) and highest among the Orientals (5.51%). The Sephardi infants occupy a halfway position (5.25%) and are nearest to the general percentage. Between the two extremes there is a difference of nearly 1% and this may indicate that Ashkenazi infants are bigger from birth. The highest proportion of

newborns in all three communities is in the 3001-3250 gm weight group which forms the mode in the frequency distribution.

The three weight groups from 2751 to 3500 gm cover an absolute majority of the infants: Ashkenazi, 62.69%; Seph-

TABLE 1
Distribution of infants by community and weight

WEIGHT	ASHKENAZI		SEPHARDI		ORIENTAL		TOTAL	
	No.	%	No.	%	No.	%	No.	%
750-1000	1	0.02	..	...	..	...	1	0.01
-1250	4	0.09	1	0.08	3	0.10	8	0.09
-1500	6	0.14	3	0.23	3	0.10	12	0.14
-1750	13	0.31	2	0.15	7	0.22	22	0.23
-2000	21	0.50	8	0.61	11	0.35	40	0.45
-2250	43	1.03	11	0.84	48	1.54	102	1.19
-2500	105	2.51	43	3.30	101	3.20	249	2.90
-2750	362	8.66	125	9.59	382	12.26	869	10.11
-3000	724	17.32	248	19.03	626	20.01	1598	18.58
-3250	977	23.38	311	23.86	772	24.77	2060	23.96
-3500	919	21.99	270	20.72	586	18.80	1775	20.64
-3750	536	12.83	143	10.97	323	10.36	1002	11.65
-4000	299	7.16	88	6.83	169	5.42	556	6.47
-4250	102	2.44	36	2.77	64	2.05	202	2.34
-4500	52	1.25	9	0.69	18	0.58	79	0.92
-4750	13	0.31	3	0.23	3	0.10	19	0.22
-5000	1	0.02	2	0.15	1	0.03	4	0.05
-5250	..	...	..	...	..	...	..	...
-5500	1	0.02	..	...	..	...	1	0.01
	4179		1303		3117		8599	

ardi, 63.61%; Orientals, 63.58%. The difference of percentage of newborns covered by these modal groups between the communities is smaller than in the extreme ones. The groups of infants weighing over 4 kg at birth form over 4% of Ashkenazi and Sephardi and nearly 3% of the Oriental infants. A com-

parison of the communities can be gained by the median weight of newborns in the different communities, given together with the mean.

	ALL NEWBORNS		NEWBORNS OVER 2500 GM ONLY	
	Mean	Median	Mean	Median
Ashkenazi	3210	3207	3263	3232
Sephardi	3180	3170	3235	3197
Oriental	3132	3149	3186	3150
Yemenites			3105	3078
Total	3174	3170	3227	3192

When all infants are included the differences between the mean and median are much smaller and the distribution is more symmetrical.

Our mean weight is lower than in other such investigations, whether concerning Jews or other European populations. In 1938 a mean weight of 3404 gm was found by Dr. Wahl among "population" of 5901 newborns in Cologne (Germany) (Wahl, '38). Dr. S. Peller conducted several investigations in our field. He found generally that Jewish newborns in Vienna were underweight when compared with non-Jewish newborns in similar economic strata. For primaparae the mean weight was 3097.2 gm for Jews and 3200.6 gm for Catholics (Peller, '14). These averages are based on a small number of observations, and they are lower than our figures for both groups. The same conclusion is reached in another work by the same author (Peller, '29). This time the investigation was conducted among Jewish newborns in Tel Aviv, Israel, and thus created the opportunity for more thorough scrutiny. Peller found that the mean weight of Ashkenazi newborns was 3165 gm and 2870 gm for the Orientals. While there is not a great difference between the Ashkenazi groups, our averages for the Orientals are considerably higher. We cannot therefore confirm his supposition that the difference in weight between newborns of European-born parents and Oriental parents is 200 gm.

Our survey shows a much less significant difference between the groups. It is possible that the marked improvement in the economic, social and hygienic standard of living of the Oriental groups since Peller's investigation (1927-28) has had a favorable influence on the weight of the infants and has lessened the difference between the two groups.

TABLE 2
Average weight of newborns by sex and community

	MALE	FEMALE	DIFFERENCE
Ashkenazi	3287	3130	157
Sephardi	3262	3101	161
Oriental	3200	3057	143
Total	3251	3100	151

TABLE 3
Infants weighing up to 2500 gm at birth by sex and community

	MALES	FEMALES	RATIO OF FEMALES PER 100 MALES
Ashkenazi	74	119	161
Sephardi	29	39	134
Oriental	76	97	128
Total	179	255	142

It is known that the sex of the newborn influences the weight, boys being heavier than girls. Peller ('14) found a difference of 140 gm (boys, 3164.8 gm; girls, 3020.6 gm) in Vienna. Our survey shows nearly the same difference.

From table 2 it may be seen that boys are 5% heavier than girls among the Ashkenazi, 5.2% among the Sephardi, and only 4.7% among the Orientals. Taking into consideration that boys are heavier than girls and that Ashkenazi infants are the heaviest in all our groups it is not surprising that the dis-

tribution of the infants up to 2500 gm by sex is unequal in the different communities.

The age of the mother is known to have a definite influence on the condition of the infant at birth. It therefore plays an important part in the variation in weight of the newborns. Generally, the average weight of infants of young mothers is comparatively low, and the weight increases with the age of the mother, the oldest mothers bearing the heaviest babies. Table 3 shows that this is true of all three communities. Al-

TABLE 4

Average weight of newborns by community and age of mother

AGE	ASHKENAZI	SEPHARDI	ORIENTAL
15-19	3190	2985	2992
20-24	3197	3120	3087
25-29	3185	3220	3155
30-34	3238	3245	3200
35-39	3250	3260	3215
40-44	3253	3125	3182
45-49 ¹	(3375)	(3292)	(2925)
All ages	3210	3180	3132

¹ The figures in parentheses are calculated from less than 25 observations.

though the difference between two adjacent age-groups is not pronounced, it reaches quite significant proportions when the lowest and highest groups are compared.

The extent of the increase with the age differs widely according to community (table 4). In the Ashkenazi group, the difference between the minimum and maximum weights is only 63 gm (1.97% of the average weight of all ages); among the Sephardic newborns the difference is highest — 275 gm (8.65%); it is 190 gm (6.06%) among the Orientals.

The difference according to communities is very pronounced among the young mothers and becomes blurred out in higher age-groups. If we accept the weight of the Ashkenazi new-

borns in every age group as the basis we find the following index numbers for the other communities:

AGE GROUP OF MOTHER	ASHKENAZI	SEPHARDI	ORIENTAL
15-19	100	94	94
20-24	100	97	96
25-29	100	101	99
30-34	100	100	99
35-39	100	100	99

Apparently the higher parity of the Sephardi and Oriental than that of the Ashkenazi mothers in the same age-groups is the reason for the gradual equalization of weights with the advancing age of the mother. Otherwise we might see in the previous figures a certain "order" of weight, Ashkenazi newborns being the heaviest, followed by Sephardi and Orientals.

Some years ago it was shown in large numbers of observations in the U.S.A. that the viability of the infant is a function of the age of the father as well as of the mother, and the curve of infant mortality according to age of father is similar to that of the age of mother (Yerushalmy, '38). Generally speaking the weight of the newborns increases from one age group of the fathers to the next. Up to the age group of 45-49, the increase is persistent and significant. However, we were of the opinion that this phenomenon is connected with other factors which are bound up with the age of the father, for example parity and age of mother. To investigate the influence of parity we calculated the average weight of primiparae only, by age of father. There was a certain increase in weight parallel to the age groups of the father although not so convincing as in the total population. However, the subdivision of father's age-group by mother's age has not shown any significant increase in weight by age of father. In this connection it should be remarked that generally, there is a small difference between the ages of the two parents in

Israel. In 11.4% of the couples the spouses were of the same age, in 32.8% the husband was older by not more than three years, and in another 19.4% the husband was the elder by 4-5 years. Only in 29.6% was the husband older by more than 5 years, and of this in only 6.8% by more than 10 years. Cases in which the wife was the older party are very rare, being only 6.8%, and of this in 5.6% the difference was three years or less.²

It may well be that the relation between the ages of the parents has also some influence on the weight of the infant at birth. In all communities the weight is at its minimum in cases where the mother is older than the father. As to the other groups, there are certain discrepancies. Among the Ashkenazi and Orientals, where both parents are of the same age, the newborns are heavier than those where the father is older than the mother, whereas among the Sephardi, the

² In this connection, a noteworthy phenomenon with regard to the communal settlements (Kibbutzim) must be mentioned. In this group, the percentage of couples in which the wife is older is much higher. The following table compares the relation between the ages of the husband and wife in all 4 communities and in the communal settlements, which form part of the Ashkenazi group.

	HUSBAND OLDER						EQUAL AGE	WIFE OLDER				Total
	Over 20 yrs.	11- 20 yrs.	6- 10 yrs.	4-5 yrs.	2-3 yrs.	1 year		1 year	2-3 yrs.	4-5 yrs.	6- 10 yrs.	
Ashkenazi	0.1	3.4	18.3	17.8	22.9	12.2	14.6	4.1	4.7	1.4	0.5	100.0
Sephardi	0.5	5.9	24.0	20.1	27.2	9.3	10.0	1.6	1.1	0.1	0.2	100.0
Oriental	1.4	9.8	28.0	21.3	21.2	7.0	8.0	1.1	1.6	0.4	0.2	100.0
Yemenite	2.0	5.7	25.7	19.1	25.1	9.4	8.7	1.7	2.3	0.3	..	100.0
Total	0.7	6.1	22.8	19.4	23.0	9.8	11.4	2.6	3.0	0.8	0.4	100.0
Communal settlements		0.5	8.9	15.8	23.6	10.0	15.3	9.5	13.7	1.1	1.6	100.0

From the above table it can be seen that couples in which the wife is older are generally more prevalent among the Ashkenazi Jews than the other communities. But among the members of the communal settlements, there is an even higher percentage of such couples: they constitute more than a quarter (25.9%) of the total. This can be explained by the mode of life in the settlements, where the marriage is often the outcome of previous extranuptial sexual intercourse, in which no attention is paid to the question of age of the partners.

opposite is the case. But in general the difference in average weight between these two groups is very small and hardly significant.

We have already mentioned the part played by parity. This was the next point to be examined in relation to the weight of the newborn. Generally there is a positive interdependence between parity and the age of parent, particularly of the mother, for this reason alone it is clear therefore that the weight increases with parity. The extent of increase is not equal between the different grades of parity. The index numbers given below prove this supposition (the weight of primiparae is taken as a basis = 100):

PARITY	ASHKENAZI	SEPHARDI	ORIENTAL
1. First birth	100.0	100.0	100.0
2. Second, third	104.5	106.3	104.9
3. Fourth-sixth	104.9	106.3	106.2
4. Seventh and over	107.5	108.6	107.9
All births	103.0	105.1	105.0

Generally, the most pronounced difference is between the first two rows, i.e., primiparae and multiparae, whereas the differences between the subsequent births do not show any remarkable advance. The smallest difference exists between the second and the third rows, i.e., that there is no significant difference in the average weight of newborns of second-third and fourth-sixth parity, and that the main differences are in the two extremes.

A comparison of weight according to the serial number of birth and pregnancy may be of some interest. Abortions and miscarriages are of course included in the second case only. In table 5 a comparison of the two series of figures is given. From this it will be seen that generally the differences in weight of corresponding births and pregnancies are insignificant and in most cases remain within the limits of 15-25 gm. Not only is there no common pattern for the three

communities but even in the same community there are cases when the birth-number and the pregnancy-number show the higher weight. In the majority of cases the weight by birth-number is higher than by corresponding pregnancy-number, which fact indicates that the influence of abortions and miscarriages on the weight of subsequent births is similar to that of normal births. Even accepting this principle we may conclude that abortions and miscarriages do not significantly influence the weight of the subsequently born normal, mature infants.

Neither could we trace any significant influence of the month of birth on the weight of the newborns. The minimal weight

TABLE 5

Mean weight of newborns by order number of birth or pregnancy and by community

ORDER NUMBER	ASHKENAZI		SEPHARDI		ORIENTAL	
	Birth	Pregnancy	Birth	Pregnancy	Birth	Pregnancy
1st	3119	3113	3025	3027	2983	2982
2nd-3rd	3261	3247	3215	3195	3131	3110
4th-6th	3273	3290	3217	3237	3170	3165
7th and over	3255	3353	3285	3258	3218	3198
Total	3210	3210	3180	3180	3132	3132

obtained in February among the Ashkenazi and Orientals and in November among the Sephardi. Because both largest groups have their minimum in February, this month also shows the lowest weight on the average for the total. In the maximal weight the Sephardi occur in June, whereas the Ashkenazi have their maximum in October and the Orientals in August. August is also the maximal month for the total. Anyhow there is a certain trend to have the maximum in summer months, minimum in winter.

Our material did not allow us to divide all newborns according to the economic status of their parents. It was only possible to segregate the lowest grades, i.e., these mothers who were non-paying hospital cases. (The social conditions

of this category are thoroughly investigated, prior to admittance to the hospital by the public health nurse and the admitting clerk). Dividing the whole material into two groups, very unequal numerically, we obtained the results in table 6.

TABLE 6

Mean weight of newborns by community and economic status of parents

	DESTITUTE	TOTAL
Ashkenazi	3080	3210
Sephardi	3197	3180
Oriental	3148	3132
Total	3134	3178

Among the Sephardi and Orientals the weight of newborns in destitute families is even higher (although to a very slight degree) than in the total of our population. Of course if we compare the destitute with the non-destitute families, the difference will be greater. The Ashkenazi show instead a significantly lower weight in the destitute families. More light is thrown on this aspect by presenting this small table showing the percentage of newborns weighing less than 2500 gm in total families and in the destitute families only:

	ALL FAMILIES	DESTITUTE FAMILIES
	%	%
Ashkenazi	4.6	17.1
Sephardi	5.2	10.3
Orientals	5.5	6.5

In general, there is a difference of opinion as to the influence of the social and economic (and, of course, the closely connected nutritional) status of the mother on the weight of the infant. The prevalent opinion is that the fetus gets more or less all the nourishment it requires, and undernourishment of the mother through poverty does not affect the fetus. On the other hand, the increased requirements of the fetus seem to aggravate the condition of the mother. Contrary to this

view, Dr. S. Peller has stated on several occasions, on the basis of numerous investigations, that "the prevailing opinion that the nutrition factor is of no value for the prenatal development, is unfounded and erroneous" (Peller, '29). Peller mentions that the difference in weight on social grounds is more pronounced than that caused by sex of infant, age of mother or parity. Furthermore, an inquiry made by Gershensohn ('28) on Jewish infants in Russia showed that there is a significant difference in weight of infants born during the depression period and after.

Our material does not strengthen Peller's opinion; on the contrary, the weight in the destitute family groups was higher in two communities. It may well be that a higher prevalence of high parity among the destitutes of these communities influenced this situation to a certain degree. Anyhow this phenomenon seems to us worth mentioning. A further thorough investigation into the quantity and quality of nutrition among the different communities of Israel Jews in general and during pregnancy in particular may throw more light on the problem.

The question of variations in weight of the infants during the 6 years of observation is closely connected with this latter consideration. Our "population" embraces the years 1940-45. While during the first half of this period there was economic depression, unemployment and a depressing political outlook, the scene changed in the second half: the economic situation improved gradually and reached "boom" proportions, the earnings of the people increased, in certain branches to double or treble the previous figures, and in spite of the high cost-of-living index there were categories in which the real value of the income increased. The fluctuations of the weight do not entirely correspond with this picture but are, more or less, in accord with it. The curves for all three communities show the lowest point in the years of depression and a steady improvement, parallel to the changing general conditions.

While the differentiation between the destitute and well-to-do families led us to the conclusion that this factor has no pronounced influence on the weight of the infants, the differentiation by successive years points in the opposite direction. This brings us to the supposition that the type of food consumed by destitute mothers in Israel, particularly in certain communities, rich as it is in carbohydrates, counterbalances the other deficiencies created by their economic situation. The influence of the situation is therefore general, embracing the whole population and not only a certain section thereof. It may well be that this fact entitles us to conclude that not only economic but psychological factors as well, such as a state of great anxiety, influence the intrauterine growth of the fetus. It seems to us that this may also explain all other instances of the above-mentioned authors, since in each case the economic deterioration was connected with an unstable, disturbed and anxious general state of affairs.

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THE EFFECT OF AGEING ON STATURE

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Change in stature after maturity is slow and relatively slight. Hooton ('47) has said that the period of physical decline begins no later than the 25th year, which was the estimate made by Bertillon in 1885; on the other hand Büchi ('50) studying successive age groups over a period of 9 years found no evidence of decline on the average until after the 40th year. Even though the age of onset of decline has not been definitely established, there is no question that the ageing period greatly exceeds the period of growth. This fact increases the difficulty of a longitudinal study over the entire ageing period and thus, despite the various advantages of the method, no such studies have been reported. Studies by the longitudinal method have been made for the growth period when the changes are rapid and marked and, in general, it has been demonstrated that average measurements of the same children at successive ages show the same type of growth curve as do average measurements of children selected at random and classified according to age. This is not surprising since the major contribution to change in stature during the period from birth to maturity is growth of the individual, and environmental, genetic, and possibly other factors make only a relatively minor contribution.

The assumption cannot be made, however, that the same similarity will hold between results obtained from cross-sectional and longitudinal studies of adult stature as were found between results obtained from these two methods when applied to children. This is due to the fact that the secular factor, of minor importance in children when compared to their rapid growth, may be of equal or greater significance

than the ageing factor in affecting the stature curve of samples of successive age groups measured at the same period. These secular changes have been attributed, by inference, variously to evolutionary trend, climatic environment, diet, exercise, etc. Evidence of such changes has been provided by Bowles ('32), Boas ('40) and others who have indicated that anthropometric data for populations may not be stable and that in a study of age changes the possibility of secular changes must be considered.

By utilizing measurements of long bones as well as measurements of stature, however, it is possible to separate the secular factor from the ageing factor in cross-sectional studies. Decline in stature with age has been attributed largely to changes in the spine (flattening of the cartilaginous disks between the vertebrae and perhaps some flattening of the bodies of the vertebrae resulting in increased curvature of the spine), general thinning of all weight-bearing cartilages, and the "bent knee gait," a result of inability to maintain the fully erect posture which requires muscular effort (Hooton, '47). These changes are completely independent of the length of long bones of an individual. On the other hand, long bone length bears a high correlation with stature of the individual (Pearson, 1899). A series of samples from a particular population which differ from each other in average stature (by virtue of selection of the samples) will differ in the same direction with respect to the average length of the long bones. Likewise, if both stature and long bones of successive generations are measured the effect of secular change to increase the average stature will also be apparent in an increase of the average length of the long bones. However, change in the average stature produced by the ageing factor would not be accompanied by a corresponding change in the average length of long bones.

Thus, if there is a significant trend with increasing age in sample statures after the change due to differences in long bone lengths has been removed or held constant statistically, this trend can be considered to be the result of ageing. A

determination of the extent of relationship between stature and age and the average rate of change in stature after maturity is presented.

MATERIAL AND METHOD

During a period of 22 years cadavers received in this laboratory were subjected to a series of anthropometric measurements including stature (Terry, '40). (Excepting for a small number they were measured before embalming.) The series found to be suitable for this study ranged in age from 19 to 91 years and were distributed according to race and sex as follows:

	MALES	FEMALES	TOTAL
Negro	360	177	537
White	255	63	318
Total	615	240	855

In 11% of this total group it was necessary to make corrections in the recorded height. This need became apparent from observing the photographs (lateral view) of the cadaver on the measuring apparatus and noting that the soles of the feet were not flat on the baseboard. Corrections were feasible because the measuring rod was photographed beside the cadaver. This need for correction was scattered throughout the range of ages and not limited to the older groups. Errors inherent in measuring cadavers may have increased the total variance of statures when compared to similar samples of living individuals but it is believed that errors have been reduced to a minimum in these series.

The skeletons of these cadavers constitute a part of the Terry Anatomical Collection and thus the bones are available for measurement. Three long bones, the femur, tibia, and humerus, were chosen and the following measurements taken: (a) bicondylar length of femur, (b) length of the tibia from the center of the lateral articular surface of the superior

extremity to the center of the inferior articular surface and, (c) greatest length of humerus. The lengths of the femur and humerus were taken on the osteometric board and of the tibia with spreading calipers. Both right and left bones were measured and the average was taken as the length.

The mean statures and standard deviations were determined for successive age groups of each sex and race; inter-correlations among the factors of age, stature, and lengths of the three bones were secured; partial correlation of stature with age, the beta weight, and the slope of the line of regression relating stature to age were found for each group; the equations of multiple regression for determination of stature based on length of femur and of tibia were determined; and, finally, a comparison was made between the observed stature and probable stature at 30 years of age. In the tables successive age periods both within a group and for the different groups do not always have the same span; the divisions were made arbitrarily in order to secure a number of cases in each period suitable for statistical analyses. This was necessitated by differences in age range and distribution of the available samples.

RESULTS AND DISCUSSION

In table 1 are presented the average stature and average lengths of femur, tibia, and humerus in centimeters for successive age periods, according to race and sex. Each of the 4 groups shows a decrease in average stature with increase in age. This decrease appears to be much more marked in the Negro male than in the White male series. It should be noted, however, that in the Negro male group the average bone lengths in the youngest age division are longer and those in the oldest division are shorter than the average for the total group, whereas in the White male group the average bone lengths are relatively constant in all age divisions. It is suggested that part of the decrement in stature with age of these Negro males may be attributed to sampling and/or to secular change. Likewise, the relatively large decline in stature in the White

female group between the 8th and 9th decades is accompanied by a considerable reduction in average length of long bones. The group of White females, however, is small and may be greatly affected by sampling fluctuations, and thus these results should be considered indicative only for the general trend.

TABLE 1

Averages (in cm) of stature and bone lengths for successive age groups according to race and sex

AGE	NO.	STATURE	FEMUR	TIBIA	HUMERUS
<i>Negro male</i>					
20-29	46	176.54	48.05	38.65	34.34
30-39	66	174.17	47.14	37.82	33.81
40-49	69	172.58	46.59	37.37	33.42
50-59	76	172.20	47.12	37.59	33.79
60-69	65	171.77	47.13	37.58	33.78
70-89	38	169.84	46.60	37.07	33.66
Total	360	172.73	47.07	37.67	33.78
<i>White male</i>					
28-49	49	170.92	45.36	35.07	32.79
50-59	53	170.76	45.26	35.14	32.96
60-64	39	171.54	45.65	35.58	32.94
65-69	47	169.79	45.38	35.54	33.30
70-87	67	169.48	45.47	35.44	33.00
Total	255	170.39	45.42	35.35	33.00
<i>Negro female</i>					
19-29	33	161.76	43.71	34.81	31.00
30-39	38	161.71	43.10	34.51	30.57
40-49	36	161.50	43.37	34.58	30.78
50-59	26	161.19	43.42	34.40	30.70
60-69	16	162.06	43.66	34.83	30.86
70-91	28	157.04	42.77	34.16	30.74
Total	177	160.89	43.27	34.54	30.76
<i>White female</i>					
27-39	9	162.44	43.21	32.39	30.33
40-59	11	163.09	43.52	34.05	31.08
60-69	16	162.00	42.80	33.49	30.28
70-79	18	161.28	43.01	33.43	30.71
80-87	9	152.44	41.08	31.87	29.43
Total	63	160.68	42.65	33.18	30.43

In order to evaluate the trend due to age alone, the complete matrix of intercorrelations for age, stature, and lengths of the long bones was obtained for each of the 4 groups, separately. These matrices and the means and standard deviations

TABLE 2

Intercorrelations of age, stature, and bone lengths (with means and standard deviations) according to race and sex

MEASURE	AGE	STATURE	FEMUR	TIBIA	MEAN	S.D.
<i>Negro male</i>						
Age					48.96	15.51
Stature	— .237				172.73	7.81
Femur	— .107	.817			47.07	2.90
Tibia	— .154	.857	.846		37.67	2.49
Humerus	— .078	.821	.829	.857	33.78	1.88
<i>White male</i>						
Age					61.16	12.25
Stature	— .091				170.39	7.34
Femur	— .007	.859			45.42	2.41
Tibia	.044	.816	.888		35.35	2.14
Humerus	.031	.751	.855	.827	33.00	1.79
<i>Negro female</i>						
Age					46.71	17.64
Stature	— .203				160.89	6.53
Femur	— .087	.835			43.27	2.34
Tibia	— .086	.809	.874		34.54	2.10
Humerus	— .018	.748	.823	.831	30.76	1.58
<i>White female</i>						
Age					63.43	16.07
Stature	— .314				160.68	7.51
Femur	— .109	.851			42.65	2.50
Tibia	— .075	.841	.895		33.18	2.09
Humerus	— .135	.802	.871	.831	30.43	1.73

of each measure are given in table 2. It can be seen from this table that the relationship between stature and bone length is very high as are also the relationships between the various bone lengths. In the White male and Negro female groups the correlation between length of humerus and stature is significantly less than between length of either femur or

tibia and stature. The correlation of stature with age is negative in every group and the correlation of bone length with age is likewise negative in all excepting the White male group. In view of the high positive correlations between bone lengths and stature, these latter negative correlations (i.e., between bone lengths and age) indicate that the older groups actually never attained a stature equivalent to that of the younger groups.

In order to determine the relationship between stature and age, with the effects of varying bone lengths removed, partial correlations have been obtained. There is evidence from other data (studies in progress) that no significant additional ac-

TABLE 3

Partial correlation between stature and age, the beta weight, and the slope of the regression line relating height to age according to race and sex

RACE AND SEX	COEF. OF PARTIAL CORRELATION	BETA WEIGHT	SLOPE OF REGRESSION LINE
Negro male	— .233	— .115	— .058
White male	— .198	— .101	— .060
Negro female	— .244	— .129	— .048
White female	— .470	— .234	— .109

curacy is gained by utilizing more than two long bones in the prediction of stature which supports Pearson's (1899) conclusion, that "one or two organs well selected are worth much more for prediction than a much larger number selected less carefully." Since the partial correlation is essentially the relationship of age to changes in stature not attributable to variance among bone lengths, the femur and tibia (the combination which yielded the smallest standard error of estimates for stature in 3 of the 4 groups) were the bones selected from which stature estimates were determined.

The coefficient of partial correlation of stature with age for each group is given in table 3 together with the beta weight and the slope of the line of regression relating stature to age. Each of the coefficients of partial correlation is significantly

different from zero, and thus a true regression of stature with increase in age is indicated for each of the groups. It may be noted also that these coefficients of correlation are quite consistent with each other excepting that for the White females (who constitute a much smaller group). By utilizing the Chi-square test (Weatherburn, '46) it was determined that these coefficients of partial correlation may be regarded as homogeneous, i.e., as differing only to the extent expected by sampling errors from the same population. Thus, Negroes and Whites of both sexes are alike with respect to the degree of relationship between stature and age. The best estimate of this partial correlation as obtained from these samples is $-.25$. The beta weights indicate the slope of lines relating stature with age when both are expressed in standard deviation units ($\frac{\text{Deviation from mean}}{\text{S.D.}}$). When the beta weight is multiplied by the ratio of the standard deviations of stature to age for each group the result is the slope of the partial regression equation relating stature with age for the samples used in this study. These slopes do not vary more than might be expected from sampling errors and their weighted average gives an estimate of decrease in stature for this population of .06 cm per year or 1.2 cm in 20 years.

The best fitting equations of multiple regression for the determination of stature based on lengths of femur and tibia and on age for each group were determined as follows:

$$\text{Negro male stature (standard error of estimate 3.51)} = 64.92 + (0.89 \text{ femur}) + (1.75 \text{ tibia}) - .06(\text{age} - 49.0)$$

$$\text{White male stature (standard error of estimate 3.62)} = 52.49 + (1.81 \text{ femur}) + (1.01 \text{ tibia}) - .06(\text{age} - 61.2)$$

$$\text{Negro female stature (standard error of estimate 3.33)} = 60.84 + (1.49 \text{ femur}) + (1.03 \text{ tibia}) - .05(\text{age} - 46.7)$$

$$\text{White female stature (standard error of estimate 3.23)} = 53.18 + (1.33 \text{ femur}) + (1.53 \text{ tibia}) - .11(\text{age} - 63.4)$$

Whatever the age at which stature begins to decrease, this figure should be substituted in each of the above equations in order to determine the average maximum height for individuals from that particular population. Thirty years has been assumed, arbitrarily, to be the age at which stature may

begin to decrease and the formulae have been applied to each of the age divisions in the corresponding groups recorded in table 1. The results are listed in table 4 under "estimated stature at age 30" and a comparison is presented between these statures and the observed statures (at the time of death) with the differences tabulated. It may appear from a superficial examination that the changes in stature with age are not linear, since the amount of loss in stature does not increase uniformly in passing from one age division to the next. However, it must be remembered that these losses are no more exact than is indicated by the standard error of the estimated stature for each group.

A further test of the linearity of these changes was made by applying the same technique to data for the Negro males of the series falling between the ages of 19 and 44 years and for the White males between the ages of 28 and 50 years. There are 148 in the former and 57 in the latter group. The coefficients of partial correlation for these restricted series are not significant between stature and age but the slopes of the lines of partial regression are $-.069$ for each and therefore consistent with the slopes of partial regression lines for the total Negro and White male groups. It would appear from the evidence at hand that for the males, at least, the assumption of linearity of regression is not untenable.

In figure 1 a hypothetical stature curve for an average group of individuals from birth to 90 years of age is shown. It demonstrates the small magnitude of change in stature after maturity as compared to the marked change between birth and maturity and thus makes more understandable the difficulty of determining the exact rate of the decline at any point. Only by taking a large range of ages is it possible to demonstrate that the total decline is significant. Büchi's study ('50) of groups of individuals of different ages over a 9-year period indicates an increasing rate of decline; however, the number of individuals in each age group was small (with only 6 males and 4 females above 65) and the individuals themselves showed considerable variation. If the rate of decline

actually increases with age more exhaustive longitudinal studies will be necessary to definitely establish the fact.

In table 4 there is evidence to support the statement that both age changes and secular trends are evidenced in cross-sectional studies of stature. The samples considered in this study range in age from 19 to 91 years and have been taken over a 22-year span, thus the year of birth cannot be determined from inspection. Nevertheless, in general, it is true

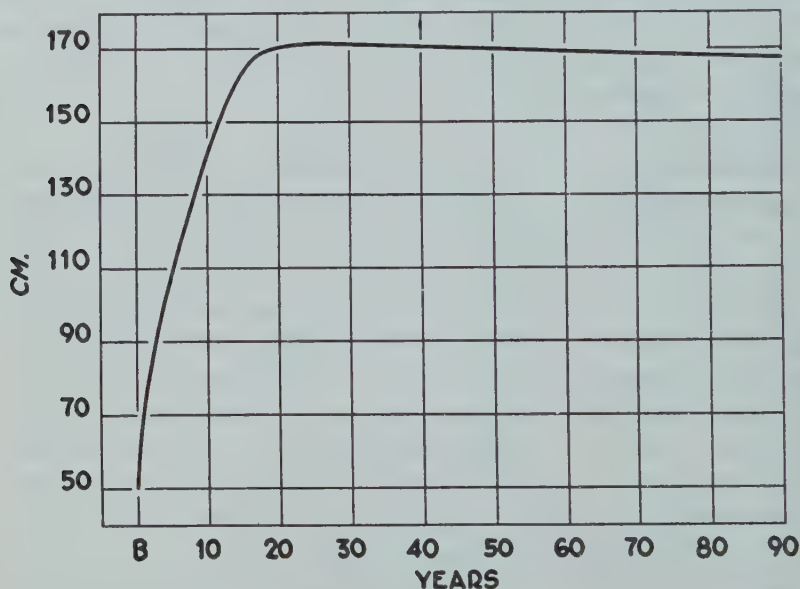


Fig. 1 Hypothetical average stature curve from birth to 90 years of age.

that the older groups were born in earlier periods than the younger groups. In the Negro male group and to a certain extent in both female groups this factor is very evident; the estimated heights show a definite trend from the youngest to the oldest age divisions, the total change in the Negro males amounting to more than the change due to ageing. Whatever the secular trend may be, it is quite evident that it must be extracted in order properly to evaluate the amount and significance of age changes in stature after maturity.

In order to obtain a check on the universality of the rate of stature decrease with age obtained from the Terry Collection the data presented by Rollet in 1888 were tested by the same

TABLE 4

Comparison of estimated stature at age 30 with observed stature according to race, sex, and age

AGE	ESTIMATED STATURE AT AGE 30	OBSERVED STATURE	ESTIMATED MINUS OBSERVED STATURE
<i>Negro male</i>			
20-29	176.46 \pm .52	176.54	— .08
30-39	174.20 \pm .43	174.17	.03
40-49	172.92 \pm .43	172.58	.34
50-59	173.78 \pm .40	172.20	1.58
60-69	173.77 \pm .44	171.77	2.00
70-89	172.41 \pm .58	169.84	2.57
<i>White male</i>			
28-49	171.84 \pm .52	170.92	.92
50-59	171.73 \pm .50	170.76	.97
60-64	172.40 \pm .59	171.54	.86
65-69	172.36 \pm .53	169.79	2.57
70-87	172.42 \pm .45	169.48	2.94
<i>Negro female</i>			
19-29	162.65 \pm .59	161.76	.89
30-39	161.43 \pm .55	161.71	— .28
40-49	161.91 \pm .56	161.50	.41
50-59	161.79 \pm .67	161.19	.60
60-69	162.60 \pm .86	162.06	.54
70-91	160.58 \pm .64	157.04	3.54
<i>White female</i>			
27-39	163.87 \pm 1.16	162.44	1.43
40-59	166.83 \pm .99	163.09	3.74
60-69	165.01 \pm .85	162.00	3.01
70-79	165.20 \pm .79	161.28	3.92
80-87	160.22 \pm 1.16	152.44	7.78

technique. It is well known that Pearson (1899) based his studies for determining stature from length of long bones on Rollet's measurements of 50 male and 50 female French cadavers. Of the males, 24 were under 60 years of age with

an average stature of 167.17 cm, and 26 were 60 years and over with an average stature of 165.40 cm — a decrease of only 1.77 cm. In the female group 25 were under 60 years with an average stature of 154.04 cm, whereas the 25 cadavers which were 60 years and over had an average stature of 154.00 cm — a negligible decrease. Pearson noted these differences and concluded that “whatever shrinkage may be due to old age, it is not of a very marked character in these data.” He did not note the fact that the older group of females had a greater long bone length than the younger group and, therefore, had been taller individuals in their younger years than the stature measurements after death indicated. That this was the case is shown by the correlations between age and stature and between age and lengths of femur and tibia for Rollet’s material (table 5).

TABLE 5

Correlations between age, stature, and bone lengths based on Rollet’s data, according to sex

	STATURE	FEMUR	TIBIA
<i>Male</i>			
Age	— .247	— .043	— .093
<i>Female</i>			
Age	.012	.195	.257

Utilizing the correlations between length of long bones and stature obtained by Pearson, the partial correlation of stature with age for the males is — .352 and for the females — .324. The corresponding slopes of the regression equations are — .064 and — .061, respectively, indicating that the average decrease in stature was, again, approximately 1.2 cm per 20 years over the entire period. This is a remarkably close agreement with the results obtained from the American Negro and White samples and implies that the rate may be construed to cover the general population.

SUMMARY AND CONCLUSIONS

Data from 855 American Negro and White cadavers accumulated over a period of 22 years have been studied to determine changes having taken place in stature after maturity. Since the average stature of cross-sectional groups of individuals may be affected by both age and secular changes, the high relationship of long bone length to stature was utilized in order to separate the age and secular factors. The change in stature with age which is not associated with variance in bone length was obtained by means of partial correlations for groups of Negroes and Whites of each sex. It was found that:

1. There is a statistically significant decline of stature with age in each sample.
2. This relationship is homogeneous for Negroes and Whites of both sexes so that an estimate of the partial correlation for the total population studied was — .25.
3. The rate of decrement is likewise uniform in all groups and amounts to an estimate of 1.2 cm per 20 years.
4. The assumption of linearity of regression of stature with increasing age is not untenable.

Rollet's data based on 50 male and 50 female French cadavers were found to show the same relationship of stature to age as exists in the American samples, yielding again an estimate of a 1.2 cm decline per 20 years. Thus, it is indicated that this average rate of decline in stature may be applicable to the general population.

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HEREDITY AND ENVIRONMENT.—It has been an age-old question to ask, "How much of the specific phenotype of an individual is due to heredity and how much to environment?" . . . What the question endeavors to ask is the following. "How much of the variability observed between different individuals is due to hereditary differences between them and how much to differences in the environments under which the individuals developed?" Even this formulation requires further precision. It is not applicable to "the" phenotype as a whole but only to well-definable, measurable, or classifiable components. One can easily measure the weight of a person, the length of any specific structure, the basic metabolism, the speed of reaction in finding his way through a maze, and innumerable other traits, but it is less informative to give quantitative expressions to such properties as *general body build, constitution, or personality. Indeed, progress in an understanding of these complex attributes is made only by analyzing them into separate factors.* The question regarding the relative parts of heredity and environment in the determination of differences between individuals must, therefore, be applied separately to measurable components of the phenotype and often leads to a different answer for each separate component. — C. Stern, Principles of Human Genetics, 1949, pp. 453-454.

THE USE OF MIDDLE-PHALANGEAL HAIR IN POPULATION STUDIES

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INTRODUCTION

Danforth ('21) was the first to call attention to the hair on the middle segments of the fingers in man and other anthropoids, and the first to investigate the mode of inheritance of this trait in man.¹ His conclusion, based on family-line studies, that the presence of hair on the middle phalanges is dominant, in a Mendelian sense, over its absence, has been confirmed by other family-line investigations. Moreover, it has been shown that middle-phalangeal hair on a greater number of digits is dominant over a lesser number. The hypothesis has been offered that multiple alleles, with graded dominance account for this phenomenon (Bernstein and Burks, '42; Bernstein, '49).

Danforth also noted that the percentage of individuals exhibiting middle-phalangeal hair varies from population to population. He observed that middle-phalangeal hair is rare in some American Indian groups, more common among American Negroes, and still more common among American Whites. Population differences have also been demonstrated by other authors. Sewall ('39) reported that it was very rare among Eastern Eskimo, while the extensive investigations of the Boyds have shown a high incidence of middle-phalangeal hair among various European and Near-Eastern peoples (Boyd and Boyd, '37, '41a, '41c; Boyd, '50).

¹ Danforth referred to the trait as "hair on the middle segments of the digits." Subsequently it was termed "mid-digital hair." Since mid-digital hair properly refers to hair on the third digit, and not to the middle segment or phalanx, the author now suggests the term "middle-phalangeal hair" and uses this term throughout the present article.

So far, it has not been possible to correlate middle-phalangeal hair with other traits (Boyd and Boyd, '37), nor is there evidence of linkage (Boyd and Boyd, '41b; Kloepper, '46).

Since this trait has a known mode of inheritance, and since the incidence appears to vary from population to population, it is a potentially useful tool in population studies, as has been pointed out (Boyd, '50; Garn, '50). But before it can be used extensively, its limitations must also be known. Is this trait unaffected by age and sex, or are age and sex differences sufficiently great to limit its utility? Is observational error minimal, or is it seriously large? Can population frequencies be transformed into gene frequencies, or is this step premature? Finally, are there variables other than the presence or absence of middle-phalangeal hair and the number of digits affected that should be considered in making routine observations?

It is the purpose of this paper to discuss age and sex differences in the incidence of middle-phalangeal hair, to provide additional data on the subject, and to discuss sources of observational error. Finally, it is the purpose of this communication to provide data on the combination of digits affected.

AGE AND SEX DIFFERENCES

Whenever data on males and females have been tabulated separately (and many workers have failed to do this), sex differences in the incidence of middle-phalangeal hair have been observed. In Danforth's original paper, data on males and females are given separately for each of 6 groups investigated: in all 6, such sex differences exist (Danforth, '21, p. 202). Boyd ('50, p. 285) has recently brought together data on 14 groups: in 12 of the 14 groups the percentage of males with middle-phalangeal hair exceeded that in females. In 3 of the 14 groups the sex differences approximated or exceeded 20%. Thus, the incidence in East Georgian males (at Tiflis) was 56.4%, in contrast to 33.8% in the females of the same

group. In the author's own data on 78 adult Aleut from the Aleutian Islands, middle-phalangeal hair was observed in 66.7% of 42 males, and in 41.7% of 36 females (table 1). Clearly, sex differences in the incidence of this trait do exist and must be considered.

Surprisingly, little attention has been given to possible age differences in the incidence of this trait. Without examining the situation further, workers have either combined data on adults and children, or have failed to give any indication of the age range included. Thus, in Kloepper's linkage study, "offspring" aged 3 to 36 years were included. In Bernstein's

TABLE 1

Middle-phalangeal hair in Aleut adults and children, in Boston males, and in castrate males and controls

GROUP	NUMBER OBSERVED	PER CENT WITH MIDDLE-PHALANGEAL HAIR
Aleut males	42	66.7
Aleut females	36	41.7
Aleut children	72	21.5
Boston males	239	66.9
Male castrates	81	48.1
Male controls	82	58.5

study, age and sex can only be inferred from the description of subjects, and in Boyd's tabulations age is not stated. Boyd informs the author that both adults and children, "but not very young children," were included (personal communication).

Actually, there is evidence that middle-phalangeal hair, like much of the hirsute covering of the body, is affected by age as well as by sex. In the author's Aleut series, middle-phalangeal hair was present in only 21.5% of 42 Aleut children under 16 years of age, in contrast to 41.7% in adult females, and 66.7% in adult males (table 1). Such an age difference also exists in Whites. In a pilot series of 100 Boston children at the Forsyth Dental Infirmary for Children, middle-phalangeal

langeal hair was noted in 45% in contrast to 67% observed in adult males from the same community (Garn, '50). It may be noted that Kloepper's raw data also suggest an age difference, though smaller than those noted here. Therefore, age as well as sex appears to influence the expression of this trait.

Since the incidence of middle-phalangeal hair varies with age and sex, it is not unreasonable to suspect that this trait is hormone-mediated, as well as genetically determined. Naturally, direct experimental confirmation is presently out of the question, but there is excellent indirect evidence that this assumption is correct.² The incidence of middle-phalangeal hair is less in castrate males than in normal controls.

Dr. M. M. Gertler and the author examined 81 castrate males and 81 controls from the same institution. Although the castrate males averaged 9 years older than the controls, middle-phalangeal hair was present in 47 of the 81 controls (58.1%) and in 39 of the 81 castrates (48.1%). Moreover, the luxuriance of the growth in the controls exceeded that in the castrates, with a modal score of one in the controls (on a scale of 0 to 4) and zero in the castrates (Garn and Gertler, '51).

It is likely then that steroids of both adrenal and testicular origin stimulate the growth of middle-phalangeal hair, and that the presence of this trait is a function of steroid output as well as genetic make-up.

OTHER SOURCES OF OBSERVATIONAL ERROR

In occasional matings reported in the literature both parents appeared to lack middle-phalangeal hair, yet some of the offspring exhibited this trait, contrary to expectation. This finding has prompted several authors to consider possible sources of observational error. It was realized that "active" follicles might be overlooked, resulting in an "incorrect diag-

² In women with virilizing ovarian tumors, with *excessive excretion* of 17-ketosteroids, middle-phalangeal hair production may be marked. One such individual (a nurse) observed by the author, had centimeter-long middle-phalangeal hair in the 3-4 combination. According to her, neither parent possessed the trait in question.

nosis." It was also noted that certain occupations subjected the fingers to abrasion, and hence to loss of the hair on the middle phalanges. In particular, housewives and carpenters have been considered unduly subject to loss of the middle-phalangeal hair.

It should also be noted that individuals may be mistakenly diagnosed, not because their middle-phalangeal hairs were lost in the dishwater or the sawdust, but because the hairs were unilaterally present (and only one hand was examined), or because the follicles were in the replacement stage.

As an example of the former possibility, in the author's Aleut series 4 out of 43 adults exhibited middle-phalangeal hair on one hand only. (In the Boston adult series the exact incidence of asymmetries was not recorded.) But in either series, if the data had been based on the routine observation of the left hand only, the incidence would have been lower than that reported.

It is well known that hair follicles are not continuously active. For any hair, there is a growth stage and a resting stage, followed by loss and eventual replacement. Where the total number of middle-phalangeal hairs are few, the process of growth and replacement may affect the diagnosis. In the author, for example, there is presently one middle-phalangeal hair on digit IV of the right hand. This was absent less than a year ago, but a single hair, comparably-located, was present prior to that time. At the present time, the author would be recorded as having middle-phalangeal hair, with the presumed A_1 genotype. Earlier he would have been recorded as having no middle-phalangeal hair.

Hence, in population studies, failure to record observations on both hands, or failure to correct for the process of hair loss and replacement, may spuriously lower the observed incidence of middle-phalangeal hair.

COMBINATION OF DIGITS AFFECTED

In the majority of the investigations, attention has been centered upon the presence or absence of middle-phalangeal

hair. In a few studies, interest has extended to the number of digits affected (Danforth, '21; Bernstein, '49 Bernstein and Burks, '42). These studies have shown that the modal number of digits affected differs from population to population, and that multiple alleles must be considered rather than a simple mendelizing pair.

However, it should also be pointed out, that middle-phalangeal hair does not occur on any digit, or any combination of digits at random. If any digit is affected, it is most likely to

TABLE 2
Combinations of digits with middle-phalangeal hair

DIGIT COMBINATION	120 ALEUT ¹		146 WHITE ² MALES		81 CASTRATES ³		81 CONTROLS ³	
	no.	%	no.	%	no.	%	no.	%
0	68	56.7	55	37.7	42	51.9	34	42.0
III	2	1.7	2	1.4	1	1.2	4	4.9
IV	14	11.7	18	12.3	9	11.1	10	12.3
III-IV	23	19.2	31	21.2	10	12.3	9	11.1
III-IV-V	11	9.2	37	25.3	19	23.5	22	27.1
II-III-IV-V	1	0.8	3	2.7	0	0.0	0	0.0
IV-V	1	0.8	0	0.0	0	0.0	2	2.5

¹ Adults and children combined to show digital combinations, not for population frequencies.

² Data from Gertler, Garn and White ('51).

³ Data from Garn and Gertler ('51).

be the 4th. When combinations of digits are affected, the 4th is always affected. All combinations include the 4th digit, and next in order, usually include the 3rd. In less than 2% of the author's cases (and 1% of Danforth's cases) where middle-phalangeal hair was present at all, was the 4th digit *not* affected.

In the author's data (on 522 individuals) random digital combinations such as 2-4, 2-5, or 3-5 were never found, and only combinations involving the 4th digit were found (as

shown in table 2). The most common combinations were 3-4-5, and 3-4, and the least common were 2-3-4-5 and 4-5³ (table 2).

Evidently hair centers about the 4th digit, and in extension tends to affect the 3rd digit twice as often as it affects the 5th. This is shown not only by the combinations, in which the combination 3-4 is much more common than the combination 4-5, but also by the fact that middle-phalangeal hair may be present on the 3rd digit alone, but has never yet been observed (by the author) on the 5th digit alone.

These facts suggest that the trait, middle-phalangeal hair, centers about the 4th digit, and extends field-like, with a gradient heaviest on the radial side.

DISCUSSION

The ideal trait, from the point of view of population genetics, is affected neither by age nor by sex, so that all of the individuals in the population can be utilized in the study. Middle-phalangeal hair, however, fails to come up to this ideal, for it is affected both by age and by sex, and even in the adult male the phenotype may not be equated with the genotype. Hence, middle-phalangeal hair, despite its advantages, has many of the limitations of the more commonly used morphological traits.

It should be obvious that population frequencies obtained by combining data on males and females, adults and children, are of no particular use. Some of the tabulations in the literature are so made. Others present data on the incidence of middle-phalangeal hair in males and females separately, but without regard to age. Rarely are tabulations given for adult males or adult females alone. Hence the tabulations, made as they are in various ways, are not comparable. It is indeed unfortunate that the precautions ordinarily taken by physical

³ The digital combination 3-4 is far more common than the combination 4-5. While both are represented by the same notation (A_2) and are presumed to represent the same genotype, it is doubtful that this assumption is correct.

anthropologists have not been employed by geneticists interested in this trait.

Since the observed frequency of middle-phalangeal hair is ordinarily highest in the adult male, it would seem that estimates of gene frequency (if made at all) should be restricted to data on adult males. However, observational error may be large, and in populations where the observed frequency is well below unity, little would be gained by this procedure.

But in considering this trait, which does possess a number of advantages, and which can even now be used in comparing populations, one should not neglect the number of digits affected, or the combination of digits. Bernstein's data indicate that the number of digits affected, as well as the presence or absence of middle-phalangeal hair varies from group to group. The combinations do not occur at random; the trait centers about the 4th digit, and all combinations include the 4th digit. Hence the number of digits affected may be explained by the extension of a primitive embryonic "field" and the size of the field (and hence the number of digits affected) may be associated with the degree of dominance.

In short, middle-phalangeal hair requires additional study, and improvement of techniques, before it can serve as a really useful tool in population studies. But data on the incidence of middle-phalangeal hair is not difficult to obtain, and this trait should be a routine observation in anthropometric studies.

ACKNOWLEDGMENTS

Data on the Aleut included in this paper were obtained during the 1948 Peabody-Harvard Aleutian expedition sponsored by the Office of Naval Research and the Viking Fund of New York. The Commonwealth Fund of New York and Mr. Dorsey Brown provided support for research on males mentioned herein. The Hood Fund sponsored research at the Forsyth Dental Infirmary for Children. The author expresses his acknowledgment to Mrs. Lois S. Hutchinson for assistance in preparing the manuscript.

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BREEDING OF LABORATORY ANIMALS.—“The Care and Breeding of Laboratory Animals,” edited by Edmond J. Farris, 1950, has been described by a psychologist experimenting with primates and rodents as follows: “This volume will be welcomed by experimental biologists in a variety of fields. The basic techniques in workaday animal maintenance for 15 widely used types are outlined by a panel of experienced investigators. Separate chapters are written on: rhesus monkey, rat, mouse, guinea pig, hamster, rabbit, dog, cat, ferret, opossum, domestic fowl, reptiles, amphibia, fish, and drosophila. Sufficient detail is presented to induce an intrepid attitude toward colonizing an unfamiliar form. The level of detail is not precisely uniform from chapter to chapter (104 pages are devoted to fish), but this is inevitable in a collection, even one as well edited as this.

CHEMICAL DATING OF BONE.—The experiments performed with radioacting tracers warrant the conclusion that the diffusible anions, phosphate and carbonate, can enter and leave dead or fossil bone with very great facility. It is further probable that such movement is based upon an interchange of ions between the bone substance and the external solution rather than upon a unidirectional accumulation or depletion of a single ion species. Fossil bone, therefore, behaves in a manner fundamentally similar to living bone.

Analyses of more than 400 samples of fossil bone of different ages and from widely separated localities show a remarkable constancy in content of calcium as referred to the total inorganic matter. At the same time, the relative quantities of phosphate and carbonate fluctuate over a much wider range, although the sum of these two components is fairly constant.

For these reasons, therefore, it may be maintained that the primary participation of the major mineral components in the process of fossilization involves an exchange or replacement of substance rather than an accumulation or depletion, although the existence of depletion processes on a secondary scale cannot be denied.

It must be recognized that, so far as the determination of the age of fossil bone is concerned, the inorganic constituents (save, perhaps, fluorine) are of little immediate value. The composition of any particular specimen as it comes into the laboratory will have been determined, not by the lapse of time since the death of the person or animal, but by the mutual interaction between the bone and the substances in the soil surrounding it, together with the physical conditions characteristic of the environment subsequent to the bone's burial. If a temporal sequence based on changes in inorganic components is to be established, a combined study of the bones and the corresponding soil chemistry will be necessary.—S. F. Cook. The fossilization of human bone: Calcium, phosphate, and carbonate. Univ. Calif. Publ. Am. Arch. Ethnol., vol. 40, no. 6, 1951, pp. 263-279. •

MEAN POSTURE PATTERNS WITH NEW POSTURAL VALUES¹

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TWO FIGURES

Countless school children and university freshmen have been photographed, measured and rated in almost as many posture studies as there have been individuals studied. Some have been followed in longitudinal series over a number of years with interesting correlations relative to postural changes in various parts of the body, associated with good and bad health, scoliosis and pronated feet. Osgood ('32), Schwartz ('28) devised a lumbosacral angle as a posture index and quoted Cunningham who believed the "higher" races of man — Europeans as he stated — had a greater lumbar lordosis than the "lower races." Wiedersheim (quoted by Schwartz) associated cervical ribs with poor posture. Goldthwait ('34) considered Greek sculpture models of posture. Many analysts have used plumb lines suspended from various anatomical points and computed indices and coefficients, so that the field seems to have been well covered. So intense has been the interest in posture that an American Posture League was founded. Inquiries indicate the League is still actively crusading.

¹ The work related in this article was performed under Contract W-44-109-g.m.-2241 under sponsorship of the Army Quartermaster Corps. I wish to express my appreciation to Professor E. A. Hooton, Department of Anthropology, Harvard University, for permitting and assisting with this study. Without his inspiration and cooperation it would not have been possible. Dr. Robert M. White, Quartermaster Climatic Research Laboratory, Lawrence, Mass., was of great assistance in expediting the manuscript through proper channels.

Dynamic posture has been discussed by a number of authoritative writers and will not be stressed in this report. The literature is replete with posture material of all sorts.

Silhouettographs were introduced by Norman Fradd ('23) and used later by Goldthwait ('34) and Osgood ('32) in studying posture. Others adopted this technique, using the lateral view of the individuals examined either in full or in partial profile. These sagittal sectional posture studies usually analyzed "poor" posture, with the purpose of orienting the reader toward "better" posture.

Descriptive adjectives are meaningless, as a rule, in transmitting exact information. Hence "poor" posture or "good" posture gradually became associated with body types, illustrated by black on white silhouettes, ideally constructed and not from actual composite series of real tracings (Osgood, '32). The spinal configurations were generally untouched by the artist while the abdominal protrusion was gradually reduced from the fat type to the tall, thin type.

Correlations between spinal curves and balance or poise have been frequently discussed in orthopaedic text books (Steindler, '35). Much is already known concerning the most likely posture positions in health and disease but true values of posture, as portrayed by a lateral projection photograph, needed reworking. With this in mind, I shall present mean posture types, demonstrating postural values in terms of somatotypes or body builds actually existing in a very large group of normal, healthy, young, adult White males.

MATERIAL

The Army Quartermaster Corps series of over 40,000 body build, photogrammetric studies of veteran separatees constituted the sample population from which this posture report was extracted. These body build photographs were posed and taken by trained teams of Army personnel and were made available to me by Professor E. A. Hooton, Department of Anthropology, Harvard University.

METHOD

Trained somatotypers selected 3,400 of the total as a working sample. At least 7 representations of each of 98 somatotypes were selected for tracing. Types that totalled less than 7, of which there were a few, were also included. As a rule many more than 7 of each type were projected but they would frequently completely match in outline a tracing already made. Thus the 7 actually traced represented the range of each type. They were traced by projection through a stereopticon machine onto thin paper, bringing each up to a standard 10" image.

The total number inspected was 3,400 with 483 tracings chosen to represent this working sample. For each body type a mean tracing was made by superimposing the various individual tracings made for that type and drawing the lines of the best fit. A common point for superimposition was selected, consisting of the lumbosacral junction. This was estimated to be that point in the soft tissue outline which was the center of the arc at the lumbar convexity. The point selected correlated well with roentgen studies of the same region. These will be discussed later. This point was also approximately the center of the body in the longitudinal plane and the soft parts followed the underlying bony structures well.

From these mean tracings there were then selected various body types, grouped under the following general classifications, in order to illustrate the main general divisions of body builds.

First sampling

Polar types, 1a. Fat-Non-Muscular (731, 622, 522, 423). Seven tracings of each body build enumerated were utilized to make, by superimposition, one composite or mean tracing for each type. Theses 4 mean body build tracings were in turn superimposed to produce a mean pattern and in so doing 28 individual tracings were reduced to one general representative. (Many times 28 photographs were inspected in the process.)

1 b. Fat-Submedium Musculature (632, 532, 432). A similar number of tracings were made and treated as in the above subsample.

2 a. Muscular-Thin (264, 254, 244, 234).

2 b. Muscular-Medium Fat (462, 452, 443).

3 a. Elongated-Thin-Non-Muscular (227, 226, 225).

3 b. Elongated-Non-Muscular, Medium to Submedium Fat (424, 425, 324).

4a. Elongated-Submedium Muscular (235, 236).

In each subsample type composites were obtained as stated, totalling 154 tracings. More than 600 photographs were examined in the process.

Second sampling

Polar Types plus Extremes in each component were selected. The point of this was to determine the influence on the mean posture tracings of such extreme body builds. Therefore 7 of the extreme types of 731, 622, 522, and 423 were added to subsample tracings of 1 a, and a mean tracing obtained.

In like manner, to the mean tracings of subsample 2 a were added 7 each of the extreme types 462, 264, 254, and 244, to give a composite.

And finally, to subsample 3 a were added types 227, 226, 225, and 224 with a mean pattern obtained as before. These additional tracings brought the number in the work series thus far to 266, indicating that approximately 1200 photographs were inspected in process.

Third sampling

Balanced medium types. The third sampling was done with a balanced body build in mind. That is, the first two components were balanced at 4-4, with either a 3 or 4 rating in the third component. The latter was computed by dividing height by the cube root of weight of the individual. It was necessary to examine by inspection many hundreds of photographs because of the general uniformity in posture of these

body types in order to demonstrate ranges. None possessed a hyperlordosis or a dorsal kyphosis of more than medium to moderate degree. Thus only 30 more tracings were added to the total of the series to obtain a mean of the "Balanced-Medium Type," which was later determined to be the modal type of this series of body build photographs.

Fourth sampling

Postural extremes. The fourth sample was chosen on the basis of medium to extreme values in each of the three components, but selecting in each case individuals showing the greatest stoop or the greatest hyperlordosis. Essentially this was done by inspection and each of many photographs within the three component classifications were traced. Thus were added 75 more tracings and a few more types to the accumulating total including the 622 and 522 body builds. These extreme postural patterns were added to Polar types in the First Sampling, and another series of three body build composite tracings obtained.

Fifth sampling

A fifth and final sample was selected by separating all tracings into three main divisions. To the Fat type group were added several more tracings of types, 632, 532, 432, and 412. To the Muscular type pile of tracings were added 7 each of types 472, 145, and 343. And to the Elongated sample were added 7 each of types 127, 217, 316, 135. Thus, 112 tracings were added to the 371 utilized to this point in the study, bringing the total to 483.

From each pile every third tracing was selected and a mean of each of the three main body types obtained as before by superimposition of tracings.

Final mean tracings

These were obtained for each dominant component by taking the composites of the appropriate main divisions of body

builds of the pertinent 4 samples and superimposing them. Figure 1 represents the technique used in obtaining the final mean patterns of the first, second and third component dominants.



Fig. 1 Three mean tracings, showing manner of superimposition of the 4 selected sample mean tracings to obtain final mean or composite profile. The lumbo-sacral junction is the common point of superimposition together with the horizontal plane of the photograph. F represents Fat dominant type; M Muscular type and TE Thin, Elongated or Linear type.

Lateral projections of the series of photographs used in this study were correlated with 100 lateral roentgenograms of the spine taken from the author's private and clinic files of known individuals. These were roughly somatotyped and their soft tissue outlines, as well as their body structure were indicated on the negatives.



Fig. 2 *Final Mean* body outlines of each dominant body build. From left to right: Fat type, Balanced type, Muscular type, Thin, Elongated or Linear type. These were derived from mean tracings, representing a sample of about 40,000 somatotype photographs of young, adult White male separaties from the Army.

The plates were generally long enough (14" \times 17") to include a portion of the sacrum and all of the lumbar and most of the dorsal spine. A few 36" films were used to check correlations. They were all taken with the individuals standing in the same posed position as in the photographs studied. A cervical spinal projection was taken often enough to indicate good correlation of cervical curve with the lumbar curve in all three main body types.

From these roentgen projections it seemed quite clear that the curves of the spine follow the posterior body outline with such regularity that the fat of the buttock and the occasional protrusion of the scapula do not interfere with interpretations of this outline. As the posterior outline indicated, so were the spinal curves delineated on the roentgen plates, except in the occasional full blown fat types.

INCIDENCE

From the population sample of this series the incidence of the 4 main body types considered were computed. The Fat type made up 11%, the Muscular type 11%, the Thin Elongated type 18% and the Balanced type 26%; this was also modal for the series. Intermediate types occurred in considerably smaller percentages, totalling 34% and bringing the series to 100%.

DISCUSSION

In the Harvard classification of somatotypes, Professor Hooton's scale of values for the first and second components are rated as follows. The value of 1 is minimal; 2 is very low; 3 is submedium; 4 is medium; 5 is marked; 6 is very marked and 7 is maximal. This spread of values enabled the typers to establish finer divisions of classification. Such ratings are indicated in the numerical values of somatotypes given with each sample. The values of the third component were computed as has been stated earlier.

Mean tracings of all samples indicate a characteristic posture for each dominant body build.

The "Fat" type demonstrates a short cervical segment, practically vertical with a minimal concavity posteriorly. In a full blown first component there may even be a convexity. The upper dorsal region is moderately convex and of medium length. The dorsolumbar zone is relatively straight with the lumbar area showing a concavity of moderate degree. The sacral convexity is likewise moderate in extent, yet greater than the lumbar curve. No hyperlordosis is present.

The "Muscular" type or second component mean posture pattern shows a cervical region with a greater concavity posteriorly, and a less marked upper dorsal convexity. The dorsolumbar region shows a moderate concavity as it merges with the lumbar. Here the lordosis is the greatest, often bordering on hyperlordosis at the lumbosacral junction, with the sacral convexity greater than in the other dominant types. The sacrum approaches the horizontal so that the buttocks are not tucked under the pelvis although the hips are greatly extended. This postural pattern has been considered by some students of posture as pleasing to observe. Probably this aesthetic idealized misconception has a military origin (Steindler, '35, 196-8). Clinically this body build should lead more frequently than others to degenerative changes in the lumbar region, greatest at the lumbosacral junction (Thieme, '50 and Friberg, '48).

The "Thin, Elongated" type, generally with a medium to low second component, shows a posterior concavity in a neck tilted slightly forward and an upper dorsal zone of marked convexity, long and rounded merging with a long, gradual, concave dorsolumbar and lumbar region and a relatively flat sacral segment. The back is bow-shaped, often with a sharp kyphosis in the upper dorsal convexity. Degenerative changes are usually greatest in the dorsal and cervical spine.

The "Balanced" type is located between the Fat type and the Muscular type, yet has a cervical concavity tilting slightly forward, though nearly erect, and a long gradual dorsal convexity, merging evenly and gradually with a medium dorso-lumbar and lumbar concavity. The minimal bow of this type

of back indicates good compensation, with the cervical concavity about equal to the lumbar, and the degree of dorsal convexity about equal to the sacral. As might be expected, the impression is not striking but rather indicates balance, satisfactory poise, suggesting a reasonable adaptability. It would seem to follow that setting the buttock and rolling the pelvis in under the lumbar spine flattens the lumbar concavity a good deal and represents a posture pattern found in this series in the Balanced type of body build.

All back curves of each dominant type were of the same general character, though manifesting variations within limited ranges. Thus the Fat type never demonstrated as much lumbar lordosis as the Muscular type, while the Balanced type only occasionally possessed a lordosis of considerable extent. The latter type was remarkably consistent in demonstrating smooth back curves, never extreme curves, representing excellent poise.

SUMMARY

New basic posture patterns are presented. These types are distinct and are arrived at by inspectional studies and tracings drawn from body build photographs of nearly 40,000 White male, veteran separatees from the Army. All must be considered physically fit, having passed a selective examination to enter the Army and serving a satisfactory tour of duty therein, incidentally good enough to win the toughest of all wars. These photographs were processed, typed according to the Harvard body build classification, and studied in the Statistics Laboratory, Department of Anthropology, Harvard University. A total of 3,400 were selected for range of distribution of 98 body types. Three general body types, the Fat type, the Muscular type, and the Thin, Elongated type, were collected in their respective groups together with a 4th type showing an equal degree of each component, called the Balanced type; also, finally, a residual group of unused types together comprising 34% of the sample.

Each of the main types of body build was found to possess a characteristic posture pattern. Fat types, 11% of the series, have a medium lumbar curve and a mild dorsal curve. Muscular types, 11% of the series, show a mean lumbar curve greatest of any type in the study. This regularly occurring lordosis is common to this body build, together with a medium dorsal curve. This type stands more erect and comes nearest to the aesthetically conditioned concept of "good" posture. Thin, Elongated body builds, 18% of the series sample, demonstrated the greatest deviation from the generally accepted ideals of posture. The lumbar curve is long, gradual and moderate, with an equally long and quite marked dorsal curve, approximating a kyphosis or stoop. The Balanced type, 26% of the series sample, is midway between the Muscular and the Fat types, showing a milder lumbar curve together with a medium dorsal convexity and probably representing the best adaptation of a postural character. It was the mode of the series.

CONCLUSIONS

Each Polar type of body build possesses a characteristic spinal pattern as portrayed by a mean lateral profile tracing. The Balanced type is the modal in the series and seems to represent the best adaptation to the orthograde posture in young, healthy White males. Clinical roentgen ray projections of the cervical, dorsal and lumbar spine correlate well with soft tissue outlines of the back.

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THE "BUSHMANOID" STOCK.—The recognition of a "pre-Bushman" type in the Nile valley raises the issue of the centre of origin and direction of spread of this type. Here we have at present two opposite points of view. Most South African workers have regarded the "Bushmanoid" stock as native to Africa and especially to southern Africa, whence it overflowed into North Africa; Dart ('39) has even suggested that it penetrated into Europe. Broom ('41) in South Africa supports the contrary view, favoured by several thoughtful investigators outside Africa, that the "Bushmanoid" type entered Africa from the north and has an ultimate Asiatic origin. If it could be demonstrated that the Singa skull is older than the earliest Bushmanoid crania of South Africa, it might be interpreted as evidence for the latter view. But if we accept the frontal characters of the Singa skull as those of an early stage in the specialization of the Bushman type, it might equally be argued that it represents an early northward expansion from a southern centre of origin. Until we are more certain of the relative antiquity of such South African finds as the Boskop skull and M.R.I., as well as of the Singa fossil, any hypothesis of the mutual relationship of these types which goes beyond recognizing that they are all "pre-Bushman" must remain speculative.—L. H. Wells. The fossil human skull from Singa. pp. 29-42 in "The Pleistocene fauna of two Blue Nile sites." *Fossil Mammals of Africa*, no. 2, British Museum (Natural History), London, 1951, vi + 50 pp.

MALE SOMATOTYPES AMONG THE JAPANESE OF NORTHERN HONSHU ¹

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SIXTEEN FIGURES

INTRODUCTION

This report presents the results of an investigation of types of body builds and their relative frequencies in a segment of the Japanese population. The somatotype technique devised by Sheldon was adopted, with slight modification, for classification of body build types. The data for this report were gathered in the cities of Morioka (Iwate Ken) and Sendai (Miyagi Ken) during the winter of 1945-46.

Since Sheldon's first publication ('40), numerous workers have reported on somatotypes found in special segments of the population (Seltzer and Gallagher, '46; Lasker, '47; Cureton, '47; Dupertuis, '50; Bullen and Hardy, '46; Garn and Gertler, '50; Reynolds and Asakawa, '50; Tappen, '50; Angel, '49). All these reports deal exclusively with Caucasoid populations. The somatotype method has not, until the present study, been applied to a non-Caucasoid group. The question: Are the varieties of mankind (anthropological races) characterized by different types and/or frequencies of body build — has not yet been answered.

¹ The writer wishes to acknowledge with deepest gratitude his debts to: the citizens of Morioka and Sendai; Dr. Sato, of the Iwate Ken Department of Health; Messrs. Oikawa, Oki, and Kira, his interpreters; the Morioka Red Cross Hospital staff; the Iwate Ken officials; the Chiefs of Police of Morioka and Sendai; the Directors of the Tohoku Imperial University Hospital; the Miyagi Ken officials; Governor Chiba of Miyagi Ken. Special thanks are due Drs. W. H. Sheldon, C. W. Dupertuis, and W. M. Krogman. The writer alone is responsible for the application of the somatotype technique and opinions expressed.

On the basis of the older bipolar and tripolar systems of body build classification, most investigators have offered an affirmative answer to this question. Clearly if ethnic groups show significant differences in the frequency of certain body build types it then becomes of primary importance to ascertain: (1) if body build is inherited, (2) how environmental factors affect body build, (3) if there is a correlation between body build and culture types, and (4) if racial differentiations in body build types and disease frequencies are significantly correlated.

The present study represents an initial attack on the first of these problems, by attempting to delineate the kinds and frequencies of somatotypes among a segment of the Japanese population, and by comparing them with like data derived from an American Caucasoid population.

THE SAMPLE AND ITS COMPOSITION

The subjects used in this study were drawn from the populations of two cities in northern Honshu, Japan. Sendai, the capital of Miyagi Prefecture, is situated about 200 miles north of Tokyo near the Bay of Matsushima. Its prewar population was close to half a million. Morioka, with a prewar population of about 90,000, is the capital of Iwate Prefecture. It is situated in the mountainous region of north-central Honshu about 100 miles northwest of Sendai and 60 miles south of Aomori.

Of the 544 subjects comprising the sample, 149 are residents of Morioka and 395 are residents of Sendai. All of the subjects are adult males ranging in age from 19 to 45. The great majority of the subjects were office-workers. Only 8 persons were laborers, and 31 were policemen. The subjects were obtained for photography by arrangement with various governmental and prefectural offices in both Morioka and Sendai. The ages of 541 of the subjects were known. Of this number 417 were between the ages of 19 and 35; the remainder were between 36 and 45.

Only 7, or 4.7%, of the 149 Morioka subjects were born outside of Iwate Prefecture. Of the 395 Sendai subjects 123, or 31%, were born outside of Miyagi Prefecture, most of them in Aomori, Niigata, Akita, Fukushima, Hyogo, Tokyo, Kanagawa, Yamagata, and Saitama prefectures in Honshu. None was born in Kyushu or Shikoku. A few were born in Hokkaido. Those born outside of Japan came from Hawaii, Formosa, Mexico, or the United States.

METHOD

Posing the subject

Complete standardization of pose for all subjects in the ventral, dorsal, and lateral orientations is impossible because of individual differences in postural habits and body build. Nevertheless it is necessary to attain as much uniformity in poses as possible in order that reliable data will be offered for anthroposcopic analysis, which evaluates body build traits essentially on a comparative basis.

In all cases, the subject stood on a small plain wooden pedestal, 6 inches in height, placed 18 inches in front of a white grid paper which served as a background. For the ventral view the backs of the subject's heels were placed 1 inch from the rear border of the pedestal and about 1 inch apart. The feet were directed outward, each about 35 degrees from the median plane. The shoulders were held in the normal relaxed position and the arms were fully extended. The fingers were completely adducted and directed vertically downward. The hands were placed about 5 inches out from the thighs. The subject's face was directed forward and he was asked to look directly at the camera.

In the lateral view the position of the feet was generally the same relative to the pedestal except that the placing of the lower legs and thighs in line, so that a single profile was presented, was of primary consideration. The arms and hands were posed as in the ventral view except that where possible the right arm and hand were hidden completely from

view and the left arm and hand were placed so that no part of the body profile would be obscured from view. In some cases extreme lordosis or incomplete extensibility of the arm defeated this primary consideration.

The dorsal pose was similar to the ventral, except that the arms were held farther forward to prevent shadow from obscuring the outlines of the trunk.

Photography

A Leica 35 mm camera was used during the entire project. Most of the exposures were taken on Ansco Panchromatic Ultra Speed film, although on two occasions Japanese Fuji film was used. Exposures were determined by Western Meter readings for the Ansco film, but by frequent experimental shots for the Fuji film, whose emulsions were found to lack uniformity.

The subjects were uniformly 14 feet from the lens. Distance was checked, when necessary, by tape measurements. The subjects were lighted by 5 no. 2 photofloods set in reflectors, placed two to each side, 5 feet to each side of the subject, and 3 feet to the front of the subject. A single bottom light was placed on the floor 4 feet directly in front of the subject. None of the lights was diffused. Artificial lighting was supplemented in every instance by indirect sunlight.

The camera was set firmly on a tripod and leveled, the center of the lens being 3 feet above the floor. Cards were prepared, each bearing a letter or number, for designating the institution to which the subject belonged and the order in which each subject was photographed in the series. These cards were placed on the floor against the grid background to the right of the subject. This system was not satisfactory, consuming much time and resulting in some confusion as to identity so that several subjects had to be deleted from the sample.

All films were processed in fine grain developer on the same day they were exposed. The film was then cut so that

the three exposures of each subject could be separately filed and inspected. This procedure is not recommended, however, on the grounds of economy; for subsequent printing and enlarging the 35 mm roll should be left uncut.

Printing and enlarging was done by the Photographic Laboratory of the Oriental Institute in Chicago. Glossy paper of various grades was used to give uniform results.

Although this was the basic procedure, considerable experimentation was necessary due to varied film emulsions, lighting conditions, extremes of temperature, and so on. This led to certain occasional departures from the established procedure, often with unfortunate results. Only 544 subjects were deemed suitable for inclusion in this study, out of over 700 subjects photographed.

Anthroposcopy

Sheldon's somatotype method (Sheldon, Stevens, and Tucker, '40, chapters III and IV) has undergone certain modifications in the hands of some followers of his system. It is interesting to note, however, that in spite of these modifications the system remains fundamentally the same and the results appear to be directly comparable.

In the present study there have been no striking departures from the Sheldon technique with one exception: neither measurements nor indices figured in the final assessments. The Japanese series was somatotyped anthroposcopically. The procedure was first to record the component which appeared to be clearly dominant in a hasty inspection, or if two components appeared to be of about equal strength, to note that fact. An approximate or "crude" somatotype was then estimated on the basis of certain "key" criteria, arbitrarily chosen, without careful regional study of the subject, and expressed in terms of the 7 point rating scale.

Without recourse to the crude somatotype figures, each subject was then somatotyped according to a 13 point rating scale by regions, using those regional criteria defined by Bullen and Hardy ('46). A "refined" somatotype was thus

derived. When the entire Japanese series had thus been given a crude and a refined somatotype rating, the photographs were set aside for a period of one month. At the end of this time it was felt that there could be no accurate recollection of previously assigned somatotypes. The whole series was then somatotyped again on the basis of the 13 point rating scale and the record was filed separately. This process was repeated for a third time. During this stage of the procedure there were no identifying marks on the photographs as to age, anthropometric dimensions, or provenience (institutional

TABLE 1
Method of arriving at the final crude somatotype

NO. (MK)	CRUDE			REFINED				CRUDE	
				First	Second	Third	Final	Final	
1	3	6	1	3 6 1	3½ 5½ 1	3½ 6½ 1	3½ 6 1	3 6 1	
2	2	5	1	2½ 5 1½	2 5 1½	2 4½ 2	2 5 1½	2 5 2	
3	3	5	1	3 5½ 1	3 5½ 1	3 5½ 1	3 5½ 1	3 5 1	
4	3	6	1	3 6 1	3 6½ 1	3 6½ 1	3 6½ 1	3 6 1	
5	2	5	1	2½ 5 1½	2½ 5 1½	2½ 5 1½	2½ 5 1½	3 5 1	
6	3	5	1	3½ 5 1½	3½ 5 1½	4 5 2	3½ 5 1½	4 5 2	
7	3	5	1	3 5 1½	3 4½ 1½	3 5 2	3 5 1½	3 5 2	
8	1	6	1	2 6 1½	1½ 6 1	1½ 6 1½	1½ 6 1½	2 6 1	
9	4	4	2	4 4 2	4 4 2	4 4½ 2	4 4 2	4 4 2	
10	3	4	2	3 4½ 2	2 3½ 3	3 4½ 2	3 4½ 2	3 4 2	

symbols on the photographs were covered). The influence of extraneous considerations was thereby cut to a minimum.

The 4 series of somatotype estimations, the crude and the three refined, were then tabulated in parallel columns opposite the symbol for each subject. Taking one subject at a time, each component was averaged from the three refined somatotypes so that a final somatotype was computed. The final somatotype was used in every case in the statistical treatment of the data. A sample of the actual tabulation sheet is presented in table 1.

The writer believes that the somatotypes of the Japanese as recorded herein are reasonably in accord with the Shel-

donian technique and that any revisions subsequently made in the light of advancements in photographic standardization, more precise definition of criteria, and the like, will not substantially affect the results of this study.

RESULTS

The results obtained in this study will be considered in the following order: distribution of types (1) in the whole series; (2) by age; (3) in the Morioka and Sendai samples; (4) by birthplace; (5) by institutions; and comparison of the Japanese series with American Caucasoid series.

There were 25 somatotypes represented among the subjects of the total Japanese sample. Two somatotypes are particularly numerous — 361 and 351. Their frequencies are listed in table 5. More than a third (37.4%) of the Japanese sample is found in these two similar somatotypes. These commonest somatotypes are illustrated in plates 1 and 2.

The next most populous somatotypes are 461, 252, 352, and 451, with a range in frequency of from 7.5% to 10.5%. The remaining somatotypes have frequencies of 4% or less. Only six somatotypes comprise over 70% of the entire Japanese sample. Among these six the first component is average (2-4), the second is high (5-6), and the third is very low (1-2). In all 25 somatotypes the range in the first component is from 1 to 5, in the second from 3 to 7, and in the third from 1 to 4.

In table 2 the actual and percentage frequencies of the various ratings in each of the three components for the total Japanese sample are presented. Over half the sample have the rating of 3 in endomorphy. Over 85% are rated 5 or 6 in mesomorphy. Almost 67% have the rating 1 in ectomorphy. There are no ratings of 6 or 7 in endomorphy and only 5 are rated 1 or 5 in this component. In mesomorphy there are no ratings of 1 or 2, and only 3 persons are rated as low as 3 in this component. There are none rated higher than 4 in ectomorphy and only 19 subjects are rated 3 or 4 in this component.

The mean and standard deviation for each component in the total sample are presented in table 3. The mean somato-type for the total Japanese sample is therefore 3.0-5.5-1.4. The standard deviation does not reach one full rating in any of the components. Using the 13 point rating scale this means

TABLE 2

Frequency distribution by component ratings of the Sendai, Morioka, and total Japanese samples

COMPONENT RATING	MORIOKA		SENDAI		TOTAL JAPAN	
	No.	Per cent	No.	Per cent	No.	Per cent
Endomorphy						
5	1	.7	3	.8	4	.7
4	19	12.7	105	26.6	124	22.8
3	84	56.4	223	56.5	307	56.5
2	45	30.2	63	15.8	108	19.8
1	0	...	1	.3	1	.2
66	Mesomorphy					
7	9	6.0	30	7.6	39	7.2
6	47	31.5	174	44.0	222	40.9
5	83	55.8	159	40.3	241	44.2
4	9	6.0	30	7.6	39	7.2
3	1	.7	2	.5	3	.5
Ectomorphy						
4	1	.7	2	.5	3	.5
3	3	2.1	13	3.3	16	2.9
2	56	37.6	106	26.8	162	29.7
1	89	59.6	274	69.4	363	66.9

TABLE 3

Component means and standard deviations for the Sendai, Morioka, and total Japanese samples

COMPONENT	MORIOKA		SENDAI		TOTAL JAPAN	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Endomorphy	2.8	.66	3.1	.67	3.04	.67
Mesomorphy	5.36	.72	5.5	.76	5.47	.75
Ectomorphy	1.4	.57	1.35	.56	1.37	.57

that almost two-thirds of the sample falls between $2\frac{1}{2}$ and $3\frac{1}{2}$ in endomorphy, between $4\frac{1}{2}$ and 6 in mesomorphy, and between 1 and $1\frac{1}{2}$ in ectomorphy.

There are 182 subjects who belong to the 19-25 year age group, 232 to the 26-35 year age group, and 125 to the 36-45 year age group. The frequency distribution of somatotypes

TABLE 4

Somatotypes and their frequency distribution by age groups within the Japanese sample

SOMATO- TYPE	19-25 YEAR AGE GROUP		SOMATO- TYPE	26-35 YEAR AGE GROUP		SOMATO- TYPE	36-45 YEAR AGE GROUP	
	No.	Per cent		No.	Per cent		No.	Per cent
361	37	20.3	361	56	24.2	351	24	19.2
461	31	17.1	351	34	14.6	252	22	17.6
351	27	14.8	352	22	9.5	361	21	16.8
451	25	13.7	252	21	9.0	352	12	9.6
252	13	7.1	461	18	7.8	461	8	6.4
352	11	6.0	261	15	6.5	371	7	5.6
342	9	4.9	451	11	4.7	451	5	4.0
371	4	2.2	371	11	4.7	342	5	4.0
442	4	2.2	262	7	3.0	362	4	3.2
261	3	1.6	471	6	2.6	471	3	2.4
243	3	1.6	362	6	2.6	261	3	2.4
262	3	1.6	243	5	2.2	262	3	2.4
471	2	1.1	342	5	2.2	243	2	1.6
452	2	1.1	452	5	2.2	271	2	1.6
462	2	1.1	271	2	.9	234	2	1.6
551	2	1.1	343	2	.9	343	1	.8
343	1	.5	353	2	.9	442	1	.8
552	1	.5	272	1	.4	...	..	..
561	1	.5	462	1	.4	...	..	..
362	1	.5	171	1	.4	...	..	..
...	..	..	234	1	.4	...	..	..

among these age groups differ in detail (see table 4) but in general the pattern is the same. The six somatotypes having the greatest frequency in the total sample are, with only two exceptions, the most frequent in each of the three age groups. The order of frequency, however, is not the same for any age group as for the total sample, nor do any two age

groups have the same order of frequency. The two exceptions both concern the somatotype 451, which is 7th in order of frequency for the two upper age groups. In the 26-35 year age group the somatotype 261 ranks 6th in frequency, while in the 36-45 year age group the somatotype 371 ranks 6th.

The distribution of the somatotypes changes little with age. The mean somatotype for the 19-25 year age group is 3.3-5.4-1.3; for the 26-35 year age group it is 3.0-5.6-1.4; and for the 36-45 year age group it is 2.9-5.4-1.5. The total range

TABLE 5

Percentage frequency of 25 somatotypes among Japanese and Americans

SOMATOTYPE	PERCENTAGE FREQUENCY		SOMATOTYPE	PERCENTAGE FREQUENCY	
	Japanese	Americans		Japanese	Americans
361	21.2	.6	271	.7	.3
351	16.2	..	343	.7	4.7
461	10.5	.1	462	.5	..
252	10.3	.8	234	.5	..
352	8.3	2.3	551	.4	.1
451	7.5	.3	353	.4	4.9
371	4.0	.05	171	.2	.5
261	3.9	.7	552	.2	..
342	3.7	..	561	.2	..
262	2.4	2.3	272	.2	..
471	2.0	..			
362	2.0	.9			
243	1.8	..			
452	1.3	2.3			
442	.9	2.9			

for the means of endomorphy is .4 of one unit; for the means of mesomorphy it is .2; and for the means of ectomorphy it is also .2.

Turning to the two sub-groups within the sample a basic similarity is found. Although 6 of the 25 somatotypes represented in the Sendai series are absent from the Morioka series, these somatotypes have a very low frequency in the Sendai series. The 6 most populous somatotypes of the Morioka series in descending order of percentage frequency are: 351

and 252 (both 20.8%), 361 (16.8%), 352 (7.4%), 461 (6.4%), and 451, 261, and 342 (each with a frequency of 4.7%). In the Sendai series the most populous somatotypes are 361 (22.8%), 351 (14.8%), 461 (12.1%), 352 and 451 (each 8.6%), and 252 (6.3%). The 6 somatotypes having the highest frequency in the total sample comprise 76.9% of the Morioka series and 73.2% of the Sendai series. The greatest difference between the means for any one component is .3 of one unit; the greatest difference between standard deviations for any one component is .04 (see table 3).

As noted previously 31% of the Sendai series, or 123 subjects, were born outside of Miyagi Prefecture. The distribution of somatotypes in this group follows the same pattern as that of the total sample. The 6 somatotypes accounting for 74% of the total sample, 76.9% of the Morioka series, and 73% of the Sendai series comprise 78.3% of the Sendai foreign-born. There is thus a greater concentration of foreign-born into the 6 somatotypes of highest frequency. The order of frequency of these 6 somatotypes among the Sendai foreign-born is: 361 (27.8%), 351 (13%), 461 (11.4%), 352 and 451 (each 9.8%), and 252 (6.5%). Among this group the somatotypes 442, 462, 171, and 561 are not represented.

In means and standard deviations the Sendai natives and foreign-born are practically identical in all three components. The greatest difference between the means occurs in mesomorphy and is only .21 of a unit. The greatest difference between standard deviations is .05 and is found in ectomorphy.

The frequency distributions of the 25 somatotypes within the samples from 8 institutions follow the same general pattern, although the series are of very different sizes, varying from 8 to 172. The same 6 somatotypes are most numerous. Exceptions are explained by the meagerness of the samples. However, the RK series may be exceptional because the somatotype 252 is not found in it, although there are 120 subjects in this series.

Figures 1, 2, and 3 depict graphically the relative component frequencies of the institutions. Figure 1 presents

the relative frequencies for the endomorphic ratings. Omitting the SL series from consideration because of inadequate numbers, it is apparent that in the rating of 3 the 7 institutions conform closely. The range is from 48.4% to 70.6%. The range widens in the ratings 2 and 4, but this may be reflection

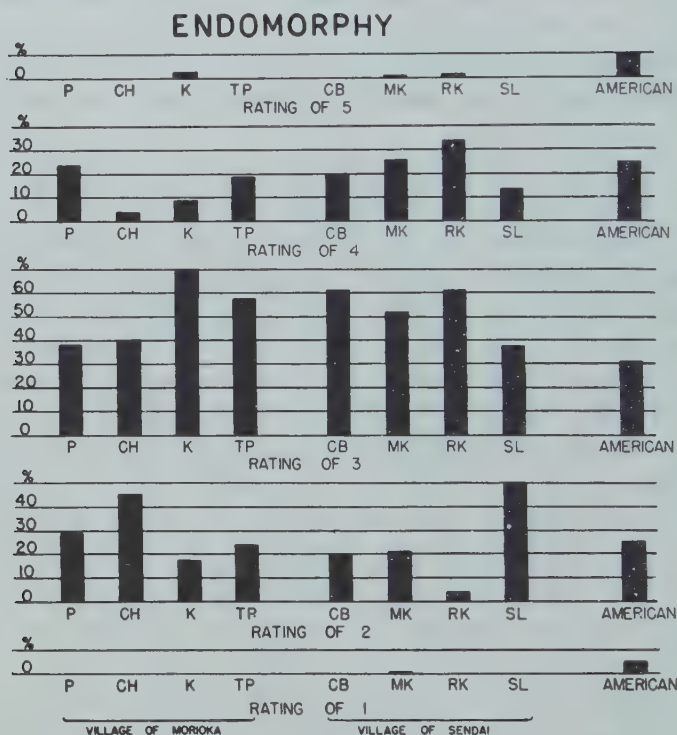


Fig. 1 Relative frequency of endomorphic ratings in Japanese and American samples.

of inadequate numbers, when the sample is broken down into 8 sub-groupings.

In the mesomorphic ratings (fig. 2) the greatest departure from the general frequency pattern is found in the K series where 82.4% of the 34 subjects making up this group have a rating of 5 and only 11.8% have a rating of 6. When considering both the 5 and 6 ratings together, it is found that all 8

series have frequencies ranging from 70% to 100%. In the mesomorphic ratings of 7, 4, and 3 there is general conformity in relative frequency.

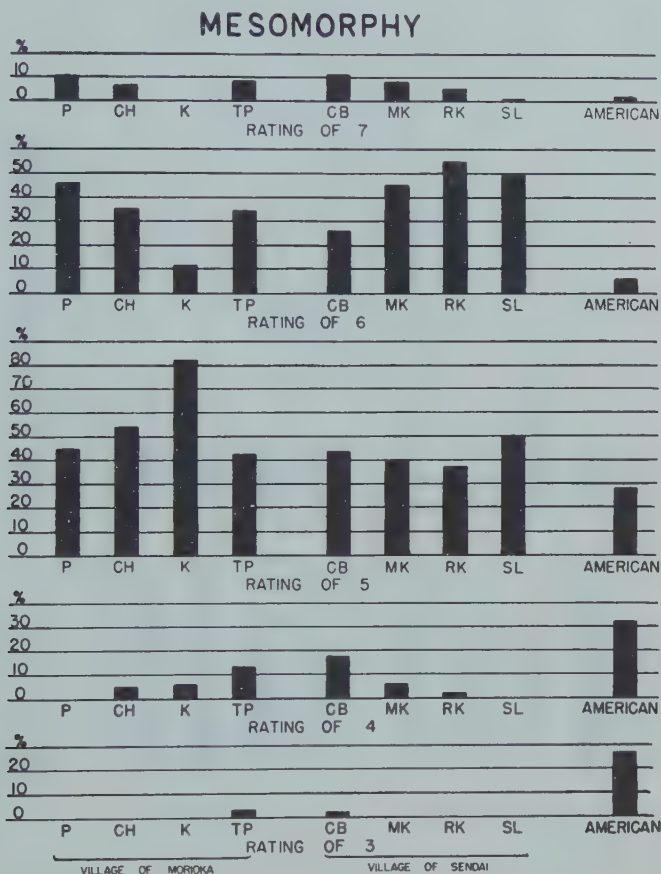


Fig. 2 Relative frequency of mesomorphic ratings in Japanese and American samples.

The relative frequencies for the ectomorphic ratings (fig. 3) show no striking departures from the general pattern. The greatest deviant from this pattern is the RK series which shows a distinct trend toward a lower rating in this component than do the other series.

The Japanese sample may now be compared with a sample from the Caucasoid population of the United States (as described in Sheldon, Stevens, and Tucker, '40). The latter comprises 4000 male students from midwestern and eastern universities. Among these subjects Sheldon found 76 distinct somatotypes. Of the 25 somatotypes found in the Japanese

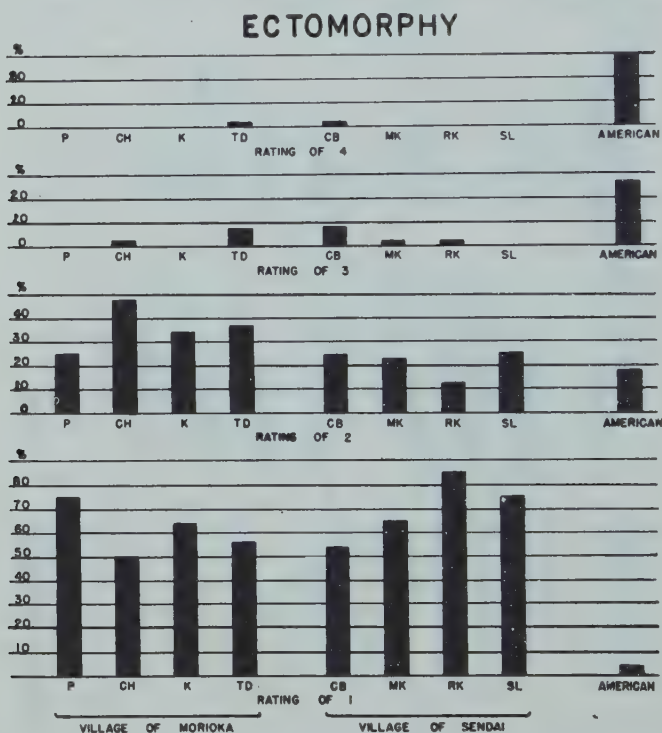


Fig. 3 Relative frequency of ectomorphic ratings in Japanese and American samples.

sample 9 do not occur among the Americans. These are: 351, 342, 471, 243, 462, 234, 272, 552, and 561. Thus 25.3% of the Japanese sample (see table 5) represent somatotypes that have not been found in a much larger Caucasoid sample. More than 75% of the total Caucasoid sample, on the other hand, represent somatotypes that were not found in the Japanese sample.

The mean somatotype for the American group was 3.2-3.8-3.5 as compared with 3.0-5.5-1.4 for the Japanese (derived from Sheldon et al., '40, table 22). As far as the mean is concerned, the significant difference between the two groups lies in the ectomorphic component in which the Japanese mean is more than 2 full units lower than the American and in the mesomorphic component in which the Japanese mean is almost 2 units higher. The standard deviations from the means for the Americans are 1.2 in the 1st and 2nd components and 1.3 in the 3rd component. Comparison with table 3 reveals that in all 3 components the American sample is almost exactly twice as deviant from the mean as the Japanese sample. The nature of the difference between the samples with respect to the relative frequencies in the ratings of the 3 components is shown graphically in figure 4. Here the Japanese sample is broken into its two constituent parts. The differences between the Sendai and Morioka groups are seen to be of a minor nature when contrasted with the American sample. The most significant difference between Japanese and Americans appears to be in the nature of the ectomorphy frequency curve: almost normal in the case of the latter, greatly skewed in the case of the former. In the 1st and 2nd components both groups present somewhat normal-appearing curves but of course the spread of the American curve is much greater in both components.

There are 14 somatotypes each having a frequency among the Japanese of 1.0% or more. There are among the Americans 28 somatotypes each having a frequency of 1.0% or more. The 14 somatotypes represent 80.8% of the entire American sample. Three somatotypes — 252, 262, and 252 — have frequencies of more than 1% each in both Japanese and American samples.

The bulk of the population in both samples is different in body types. The Japanese have somatotypes in which the endomorphic component is medium, the mesomorphic com-

ponent high, and the ectomorphic component extremely low. The Americans show a tendency toward medium ratings in all 3 components.

In working with a group showing as little variability in builds as the Japanese, one is impressed by the repeated

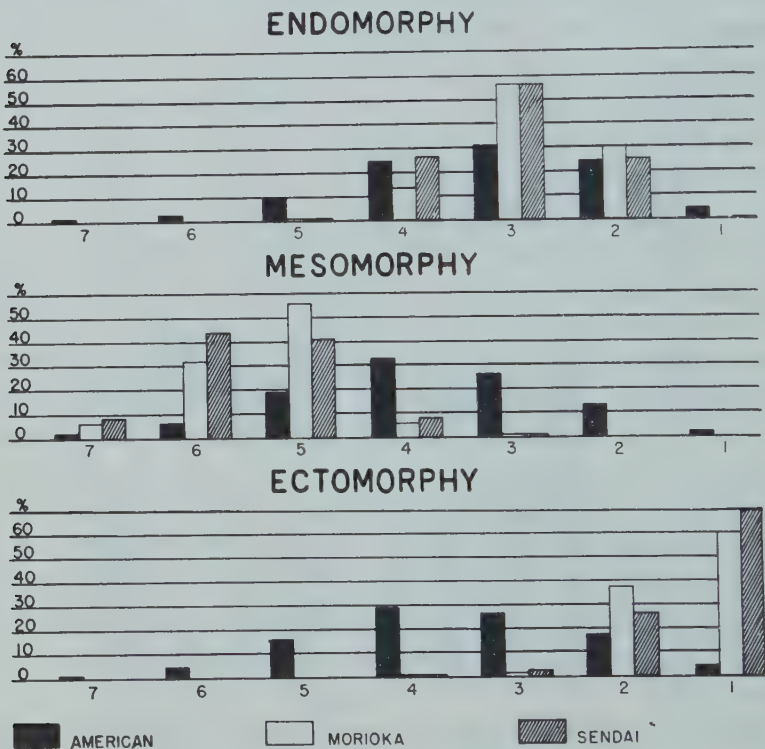


Fig. 4 A comparison of Sendai, Morioka, and American samples in relative frequency of ratings in the three components.

occurrence of certain bodily traits. Among the Japanese these traits are predominantly manifestations of the 2nd component. In particular, there is marked hypertrophy of *M. Gastrocnemius*. This characteristic appears to be an independent variable in that it may occur even when the thigh is predominantly ectomorphic. Of perhaps even greater consistency is

the strong development of the long muscles of the back, resulting in a vertical furrow of varying depth along the thoracic and lumbar spinous processes. There is also a marked consistency in the prominence of the *Mm. Brachioradialis*, *Extensor carpi radialis longus*, and *Triceps (caput mediale)* in the olecranon region. Fairly uniform also in its occurrence is the bulging of the *Mm. Vastus medialis*, *Rectus femoris*, and *Vastus lateralis* just superior to the patella. It was also observed that the presence of an abdominal pouch such as is seen in many American somatotypes having a first component rating of from two to seven is extremely rare.

SUMMARY

A sample of 544 adult Japanese males drawn from the populations of Sendai and Morioka in northern Honshu was photographed and somatotyped according to the anthroposcopic technique devised by Sheldon, Stevens, and Tucker. The subjects were largely office-workers and represented 8 governmental or public agencies. They ranged in age from 19 to 45 years. Somatotypic analysis revealed the following facts concerning this sample:

1. A total of 25 somatotypes were represented, of which the somatotypes 361 and 351 together comprised more than 37% of the total sample.

2. There are no significant differences within the sample on the basis of age groupings, places of origin, institutional affiliation, or urban location.

3. The mean somatotype is 3.0-5.5-1.4. The standard deviation from the mean is less than 1 full unit per component.

A comparison of the Japanese sample with an American Caucasoid series brought out the following differences:

1. There are 76 somatotypes distinguishable among the Americans as compared to 25 among the Japanese.

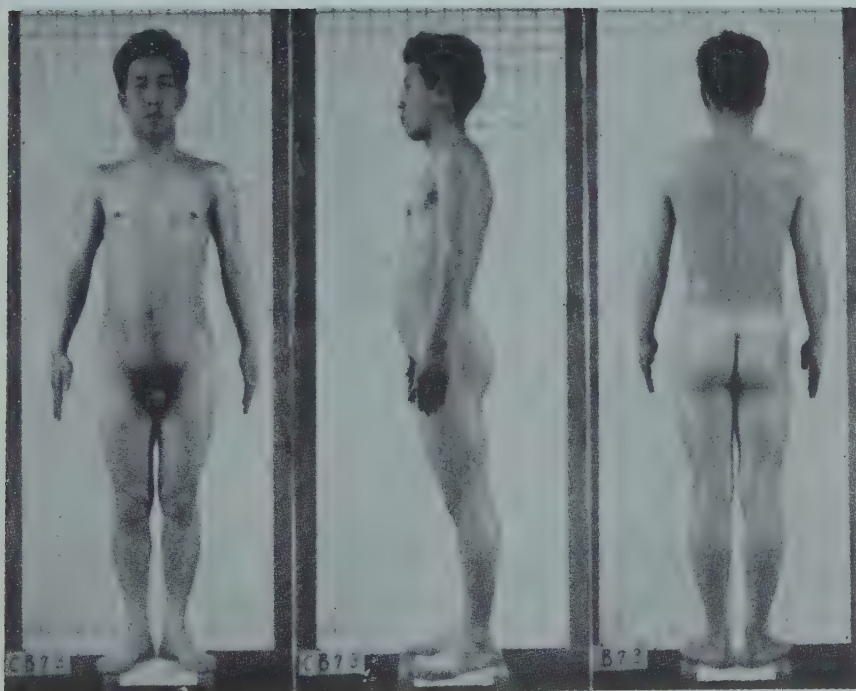
2. Nine somatotypes found among the Japanese are not found among the Americans. Somatotypes comprising 75% of the American sample are lacking among the Japanese.

3. The Japanese are considerably more homogeneous in body type than the Americans.

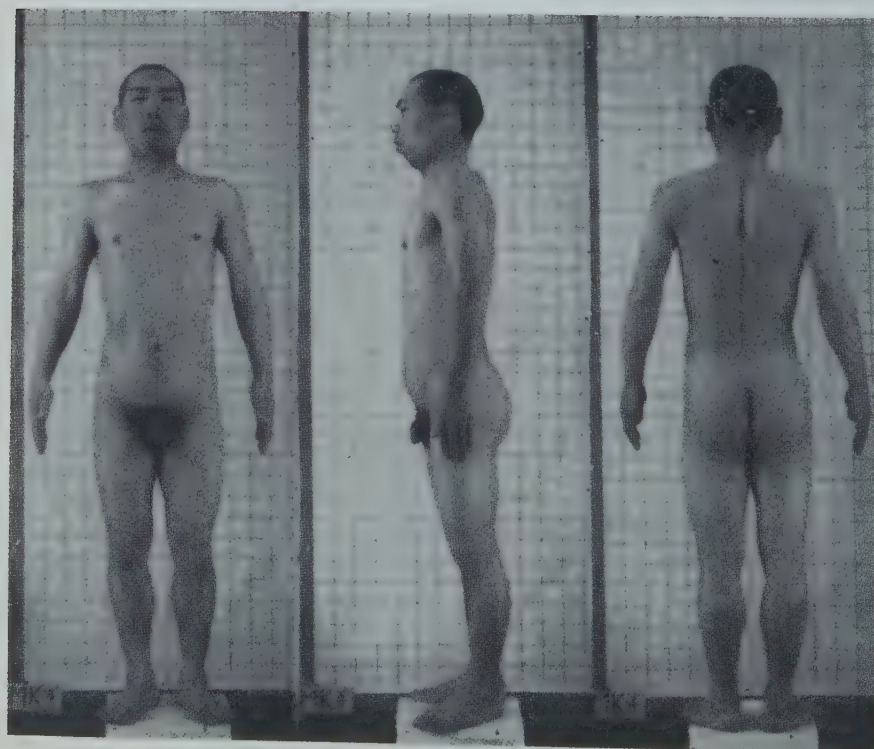
4. The Japanese on the whole are significantly higher in mesomorphy and lower in ectomorphy. Both groups are moderately endomorphic.

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Examples of the somatotype 361 (frequency — 21%)



Examples of the somatotype 351 (frequency — 16%)

BRIEF COMMUNICATIONS

NOTE ON THE NOMENCLATURE OF CERTAIN HOMINIDAE

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The brief communication by Straus in this Journal (vol. 8, no. 4) "On the zoological status of *Telanthropus capensis*" focusses attention on the matter of the scientific terminology of this and several other described hominids.

Whatever the zoological status of *Telanthropus capensis* Broom and Robinson 1949 turns out to be, both items in this binomial combination demand careful scrutiny in the light of the accepted rules of zoological nomenclature.

As a generic name *Telanthropus* must fall in view of the earlier usage of the same name by Bonarelli ('09) to include the "popoli e razze miste" listed as *T. turanicus*, *arcticus*, *mongolus*, *palae-asiaticus* and (*eskimoides*) *inuiticus* (fide Eickstedt, '37).

The term *capensis* as the second item in a binomial name has been used in various senses by numerous anthropologists. If *Telanthropus* is a hominid and the name were valid *capensis* might stand, as it would also if some substitute for *Telanthropus* were provided. But in the event of the transference of this jaw fragment to the genus *Homo*, *capensis* would be invalidated. Broom himself has formerly utilized it ('17, '18) for the extinct Boskop race. Dart ('23) applied it to fossil relics from Zitzikama. Pycraft ('25) presumably accepted Broom's earlier usage and added trinomials to cover the modern representatives of *capensis*, namely the Bushmen and Hottentots. Eickstedt ('43) adopted *capensis* in discussing the Cape Flats skull, using it as trinomial, i.e., *Homo fossilis capensis*. All these, however, are long antedated by Macgillivray's (1839) *capensis*, also used for Hottentots and Bushmen.

Whilst on the subject of nomenclatural defaulters, others come to mind and might be indicated briefly here.

Weidenreich ('45a) proposed *Pithecanthropus robustus* as specific name for the skull from Sangiran known as *Pithecanthropus* IV. Some-

time later ('45b) he considered the likelihood that the infantile Modjokerto skull *Homo modjokertensis* von Koenigswald ('36) represented the juvenile *P. robustus*. If this proves to be so then the correct name for the species will be *Pithecanthropus modjokerstensis* (von Koenigswald).

A somewhat similar example to the preceding is the Florisbad Man described by Dreyer ('35) as *Homo helmei*, but regarded as sufficiently distinct from typical *Homo* to warrant the erection of a distinct subgenus, *Africanthropus*; a title accepted by Gates ('48). (This usage, incidentally, antedated, by three years, Weinert's ['38] application of the same term as a generic name for the Eyassi fossils [*A. njarasensis*]. Gates was possibly thinking of these when he says "Perhaps *Africanthropus helmei* is the best name for it."). In a later publication Dreyer ('37) came to the conclusion that the Florisbad skull pertained to the same type as the Kanam jaw, originally described by Leakey ('32) as *Homo kanamensis*. If this contention proves correct, the name of Florisbad man must be changed to *kanamensis* Leakey and relegated to the genus (or sub-genus) *Africanthropus* Dreyer, or possibly to *Palaeanthropus* Bonarelli. In the former event the question would arise as to the status of the Eyassi material, but this need not be discussed at present.

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HEALED TOOTH FRACTURES IN A KRAPINA NEANDERTHAL

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SIX FIGURES

As early as 1905 Professor Gorjanović-Kramberger described a fractured clavicle, subsequently healed, of *Homo primigenius diluvialis* e Krapina. However, as far as I know, nobody has yet described the case of a healed tooth fracture in a human fossil. This is why I venture to put forward such a case.

While studying fossil fragments of the jaw, I found a maxilla, named "maxilla E" by Gorjanović-Kramberger. It carries the following teeth: 1 + 12345 (cf. fig. 1), and belongs to the type of the so-called "high maxillae" (according to Gorjanović-Kramberger). There are tubercula of a "flaming" type (according to Kallay) on the incisors (the tuberculum descending gradually towards the incisal edges without palatine foramen — see fig. 2).

Macroscopic examination showed no particular changes on the teeth; when, however, the median incisors were examined more closely, the right median incisor was seen to be somewhat higher on its mesial incisal edge and looked as if its crown were somewhat lifted out of its base in the mesio-labial direction. This was easily explained by an x-ray picture (fig. 3) revealing the following. Both median incisors had fractures in the height of the neck. The right one showed a frac-

ture line of irregular shape on the mesial side, more than 1 mm wide, and traversing the pulp to the distal side of the root. This fissure must have originated in the turning of the crown in the mesial-labial direction when the fracture occurred. On the opposite, distal side of the tooth, in the region of the dentine there appears a lighter triangle with its point turned towards the pulp, and its sides uneven and irregular. Cranially this triangle represents a lesion of the dentine and caudally a lesion near the enamel. This fracture therefore must

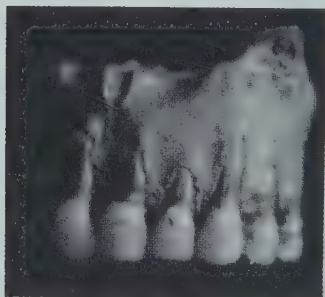


Figure 1

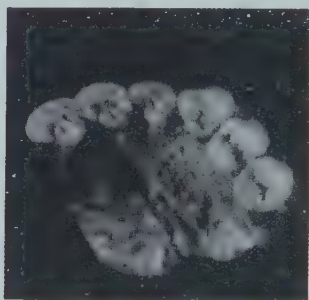


Figure 2



Figure 3



Figure 4



Figure 5

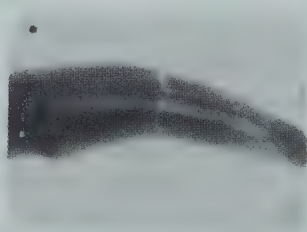


Figure 6

have been of considerable dimensions, and the whole cavity was well filled up with a mass of cement, more translucent and of a lighter shade. The cavity appears also macroscopically completely filled up because the root is vestibularly uncovered (post-mortal) by a maxillar bone (fig. 1).

The left median incisor shows a linear fracture at the same height as the right one completely healed with cement. The fracture line is mesially nearer to the enamel, thus accounting for the oblique course of the fracture.

The dislocation of the left median incisor is less than that of the right one. In spite of this the right one shows no periapical changes. It is therefore interesting to note that a somewhat paramedian x-ray picture (fig. 4) shows paraapically, from the mesial side, a widening of the periodontal membrane of the left median incisor. The outline of the otherwise sharp edge of the alveoli is blurred on this spot (5 mm long). This would speak for a paraapical ostitis developed more labially.

This finding indicates that in spite of the healing of the fracture, the pulp — which had probably remained living — got infected, resulting in ostitis. It is likely that the bacteria existing then were not so virulent as to cause a necrosis of the pulp.

An analogous recent finding of a healed fracture of a human incisor (fig. 5) confirms the assumption that we are in the presence of a healed fracture, and not simply of a fractured tooth. This picture was taken 7 years after the trauma occurred and shows the same changes as that of the above-described prehistoric case.

Figure 6 shows a postmortem fracture of a fossil tooth of *Ursus speleus* (discovered by Dr. Ivaniček in the Markuševac cave near Zagreb) which does not show the characteristics of healed fractures.

I should also like to point out that figure 4 reveals two well-developed roots in P², which is a relatively rare occurrence in contemporary human beings.

ABO AND RH BLOOD TYPES AMONG THE EWES OF WEST AFRICA

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The Ewes are a West African community, nearly a million strong, living in a triangular area of which the base is 151 km long and the

sides 161 km, the apex reaching the central mountains of Togoland. This area lies entirely in the tropics between 6° and 10° north latitude, and between Greenwich meridian on the west and the frontiers of Dahomey on the east. The Ewes are among the least documented indigenous populations of West Africa. In recent times they have been successively under German, British and French rule, and at present are being governed by both France and Great Britain under the United Nations Trusteeship Council.

This paper deals with the blood group distribution in a sample of 853 Ewes, of whom 350 are women, and all of whom were ascertained to be of pure Negro ancestry. It was impossible to assess the ages of

TABLE 1
Blood type distributions of 853 Ewes (both sexes)

	O	A ₁	A ₂	(A)	B	A ₁ B	A ₂ B	(AB)
Number	366	159	15		250	31	32	
Per cent	42.9	18.6	1.8	(20.4)	29.3	3.6	3.8	(7.4)
		M	N		MN			
Number		243	120		490			
Per cent		28.9	14.1		57.4			
		Rh positive			Rh negative			
Number		765			88			
Per cent		89.7			10.3			
	cde/cde 10.3%	cDe/cde or cDe/cDe	} 51.59%		CDc/cde or Cde/cDe	} 21.70%		cDe/cde 5.08%
	Cde/cde 2.59%	CDe/CDe 2.59%			CDe/cDE 3.56%			cD ^u e/cde 1.73%
	Cde/cD ^u e or CD ^u e/cde	} 0.86%						

the majority of the subjects because many of them have no reliable way of telling their ages. In this survey, which was done with the help of a grant from the Wenner-Gren Foundation, both dry and liquid anti-A and anti-B sera were used. A problem before us was to explain the occurrence of about 5% of Rh negatives in nearly every series of Negroes hitherto examined. Is this a genuine feature of pure Negro populations, or it is due to European admixtures?

In the case of European populations the existing antisera suffice to fix the Rh genotype with a high degree of probability, but among Negroes where the cde, cDe combinations are of approximately equal frequency, the genotypes are by no means so definite. Dr. Mourant, who has examined specimens sent to him by us, suggests that the

D_u gene is very common and that it is found more frequently among Africans, and that our sample showed the highest D_u frequency yet observed.

In addition to the Wenner-Gren Foundation, which supplied funds, we are indebted to Dr. A. E. Mourant and Dr. F. S. Stewart for the supply of antisera and the anti-D serum used in the investigation.



GENETIC BASIS OF HANDEDNESS.—A single pair of genes lacking dominance provides the genetic basis for handedness. Using R to symbolize the gene for right-handedness, and r to symbolize its alternate for left-handedness, people may be classified in three categories: RR , Rr , and rr . These result in the following types:

RR , right-handed

Rr , ambidextrous

rr , left-handed

Among identical twins:

RR , both members right-handed

Rr , one right-, one left-handed; mirror images

rr , both members left-handed

According to this scheme, genetically ambidextrous persons (Rr) are easily shifted by training and other environmental influences. As we live in a right-handed world, many people who are naturally ambidextrous become functional right-handers. Some functional left-handers are undoubtedly genetically ambidextrous, however, which accounts for the observation that in families where both parents are left-handed only about half their children are functional left-handers. Identical twins who are naturally ambidextrous consist of one right-hander and one left-hander, possibly because of the operation of an asymmetry mechanism or position during embryonic development. Persons who are genetically right-handed or left-handed (RR or rr) are not readily susceptible to training. It is these persons who may possibly become emotionally disturbed because of forced changes. Identical twins of these types are alike in functional handedness. It is the genotype of a pair of identical twins, rather than the time of the twinning process, that determines whether they will be alike or different in handedness.—D. C. Rife. Heredity and handedness. *Scientific Monthly*, vol. 73, no. 3, September, 1951, pp. 188–191.

ABILITY TO WITHSTAND STARVATION.—Two of the 13 major items of agreement among the members of the Conference on the Residues of Nutritional Insult held June 1 and 2, 1950, at the University to Minnesota Laboratory of Physiological Hygiene are:

There are important practical and theoretical questions in regard to the influence of age and sex on the occurrence and nature of residues from malnutrition and starvation. Differences in the mortality during famine have been observed repeatedly, but the possible influence of age and sex on the residual effects in survivors has not been studied. Among the major problems that relate to age and sex are possible differences in the ability to withstand starvation, the effects of maternal malnutrition on the fetus, and the speed and completeness with which rehabilitation may be achieved on a good diet.

Occidentals subjected to food deprivation in the Orient tend to exhibit more serious residue than result from similar conditions of food deprivation in Western Europe. This difference may be explained, in part, as a result of the habitual diet and in the local food stuffs used in the Orient. The foods commonly used in Western Europe in famine or periods of food shortage tend to be qualitatively superior to those eaten in comparable periods in the Orient. The question of residues of famine and malnutrition in the indigenous population in the Orient has been inadequately studied.—Ancel Keys. The residues of malnutrition and starvation. *Science*, n.s. vol. 112, no. 2909, September 29, 1950, pp. 371–373.

RECENT FRENCH PUBLICATIONS.—The following papers of interest to physical anthropologists have appeared recently in the *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, vol. 1, 10^e sér., fasc. 4–6, 1950:

Anthony, J. and Picard-Leroy, G. Observations sur la rotation du lobe occipital du cerveau chez les Primates	255–260
Chabeuf, L. Recherches sur l'omoplate vietnamienne	212–219
Delattre, A. Sur quelques points d'anatomie en rapport avec la base de l'occipitale	220–232
————— La méthode en craniologie. Etude critique	233–250
————— Les chimères craniennes	251–254
Juster, M. Données anthropologiques sur le pénis chez les Français	261–265

REVIEW

STATEMENT ON RACE. By ASHLEY MONTAGU. Henry Schuman, New York. xi and 172 pp. 1951. \$2.00

This is frankly a book with a mission. Its objective is to revise popular misconceptions about race and thus to combat racial intolerance and racism.¹ This is tantamount to being against sin, and no responsible anthropologist will take issue with it. Since professional anthropologists already familiar with Dr. Ashley Montagu's views will find nothing new, this book must be reviewed with regard to the character of the presentation and the validity of the argument.

In form it is an amplification of UNESCO's Statement on Race. In the body of the text each of the 21 paragraphs of the Statement (with exception of nos. 15-20 which are lumped) is printed separately and a few pages are devoted to each. An appendix prints the United Nations Universal Declaration of Human Rights; 9 pages contain 71 reference notes; and there is a select and annotated bibliography of 48 items.

Since Dr. Montagu was one of the authors of the Statement, his hermeneutical approach can probably be justified, although one wonders to what extent his colleagues may concur with some of the details of his exegesis. At times the stress on "fact" and "science" and the assertive tone seem too strong for even a popular exposition.²

In his first few sections the author discusses the biological bases for race distinctions in terms of evolutionary processes, and most of what he says seems unexceptionable. Throughout, however, he tends to minimize valid differences. Thus the stress is consistently on overlapping of ranges and practically never on established and possible modal differences. The variability of the human species is emphasized and so is the variability within racial groups. Montagu uses these points as a background for his assertion of constant change within groups, both by mutation and hybridization. He employs the concept

¹ An accompanying letter from the publisher calls attention to its release date at the beginning of National Brotherhood Week and describes it as a basic document for use at that time.

² The reviewer wants to go on record as concurring wholeheartedly with the editorial comments of Stewart in *Scientific Responsibility*. AJPA n.s. 9, pp. 1-3. 1951.

of changing physical patterns to demonstrate the instability of a race. However, although he does say that the process of change takes a long time and mentions a century or a millenium, there is no reference to the number of generations required for genetic changes to become established in isolated populations. Nor does he mention the very marked relative stability of physical type in inbreeding local populations over long periods of time as demonstrated by skeletal finds in archaeological context and by modern survivals of known population movements. The casual and untrained reader is likely to get a completely false impression as to the rate of genetic change. But the instability resulting from hybridization and the emergence of new patterns is well handled.

Paragraph 6 of the Statement says, in part, "Because serious errors . . . are habitually committed where the term 'race' is used in popular parlance, it would be better when speaking of human races to drop the term 'race' altogether and speak of *ethnic groups*." The author points to the use of the expression "popular parlance" and states flatly that this section does not refer to "scientists and those who know what they are talking about," except when they are talking in non-scientific circles. If this is the original intent of the paragraph, the comma after "parlance" should be moved three words to the left, for as it stands, this is definitely not the meaning of the statement.

Since "race" should be applied only to a biological concept, the substitution of "ethnic group" is unrealistic. A mere dictum that "race" should no longer be used will have no effect on customary speech. The word is deeply embedded, and people will continue to employ it. Dictionaries follow usage and do not create new forms or eliminate old ones. Lexicographers can and should stress the biological aspects of the term and indicate the incorrectness of other interpretations.

Furthermore, the arguments advanced in favor of using "ethnic group" for "race" are even more unsound. The recommendation is made on the ground that the term is imprecise, has cultural implications, and has no clear meaning. The substitution of an admittedly unclear word for a definite biological one in order to produce greater clarity seems illogical to the extreme.

A good case can be made for distinguishing between a race as a biological group and an ethnic group as a more or less culturally delimited society with or without racial overtones. This, however, is not what is proposed either in the Statement or the text. I agree that there is value in adding the term "ethnic group" to an everyday vocabulary, but only in addition to the term "race," not in place of it.

Phenotypic distinctions among the three major racial stocks are very sketchily discussed on pages 75-77, and on pages 79-82 the

author lists his own synoptic classification. The three stocks are legitimately termed divisions, but the conventional subdivisions, usually considered as races or subraces on physical grounds alone, are here called ethnic groups, whether or not they show any cultural delimitations. By this time the lay reader should be thoroughly confused as to the meaning of either race or ethnic group.

The discussions of Paragraphs 10-13, which deal with mental characters, temperament, and personality, suffer from the weaknesses mentioned earlier. Possible group differences are minimized in terms of their similar ranges, and possible modal differences are largely ignored. In treating race mixture (paragraph 13) the author takes a sound point of view and demonstrates clearly that the problem of the half-caste is primarily a social one. Unfortunately, however, he uses the rather tired evidence of the Alpha and Beta tests on World War I draftees. Although the results do clearly imply socio-economic factors, a confirmed racist can attribute the superior performance of certain of the negro groups to a greater proportion of white admixture. The use of these data, furthermore, implies that these tests are valid, and that intelligence can be measured as a conceptual whole rather than as a series of separate qualities. Whether innate capacity can be tested apart from cultural conditioning is not involved, for the author considers intelligence as a part of social development. The juxtaposition of Angel's findings with relation to ancient Greek civilization is also dubious, for that study deals with subracial and ethnic groups on a different level of abstraction.

Throughout the book and particularly in the amplification of paragraph 14 the use of the term "myth" or "social myth" for racism can further becloud the issue. This has already been discussed by Stewart.³

The closing section, while excellent for the most part, asserts as demonstrated fact that the principle of cooperation is innate and biological and that man is by nature altruistic. Although rightly aimed at the overemphasis on competition and the survival of the fittest, this argument seems overweighted in the opposite direction. The reviewer for one, although recognizing the necessity of cooperation as a selective factor in group survival, is not as yet prepared to accept it as an innate biological drive.

The discussion (pp. 121-124) of human equality as an ethical principle of dignity and rights in spite of differences in human endowment is well taken. This is perhaps the best passage in the book. A further point which might have strengthened the argument would

³ Stewart, T. D. *Scientific Responsibility*, AJPA n.s. 9, pp. 1-3.

have been the recognition that any group differences in endowment are more than counterbalanced by the failure to make full use of existing capacities.

Since a revision of the original UNESCO Statement on Race is scheduled, much of this review may seem like whistling in the wind. However, this is a book designed for the public, and it must be treated as such. It seems unlikely that it will convert many racists, and for those on the other side of the fence it may well promote or reinforce erroneous convictions. A student who appeared recently in our office of curriculum counseling wished to make his career in the field of race relations. In spite of having taken an introductory course in anthropology and a course in race relations, when asked what he knew about race, he replied blandly, "There is no such thing as race." This attitude is symptomatic of an all too common tendency to isolate oneself against unpalatable evidence in order to protect a point of view. There is little to be gained by encouraging the substitution of one set of misconceptions for another. In the long run it will defeat its own purpose, and the public will quite properly mistrust even anthropologists when they speak on race.

There can be no question but that the objective of this book is unimpeachable. On many points I find myself in complete agreement with the author. There are, however, areas in the argument and some conclusions which seem highly questionable, particularly when presented to the layman in accents of authority. When writing for an inadequately informed public it is even more important to distinguish carefully between data, interpretation, and opinion than it is when writing for a professional audience. On the other hand, I must confess that I feel guilty to be sitting back and criticizing while Dr. Montagu attempts to do a job that urgently needs to be done.

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THE PLACE OF NEANDERTHAL MAN IN HUMAN EVOLUTION

F. CLARK HOWELL

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NINE FIGURES

INTRODUCTION

Two major theories have been advanced to explain the relationships of the Neanderthal fossil hominids to modern man. One, supported by Keith ('29, '31), Hooton ('31, '46), Howells ('44), and Boule ('23, also Boule and Vallois, '46), regards the Neanderthals as extinct or replaced hominids, collateral relatives of modern man. In their report on Mount Carmel, McCown and Keith ('39) regard Neanderthal man and modern man as descendants of a common stock with "differentiation along, at the least, two directions — towards the purely Paleoanthropic (Neanderthal) type and towards a Neanthropic type, represented by the early people of Cro-magnon." The other view, advocated by Hrdlička ('27, '30), Sergi ('44, '48), and Weidenreich ('28, '43a), considers some portion of the Neanderthal assemblage as directly ancestral to modern man.

The idea that Neanderthal forms were collaterals of modern man, believed to have become extinct, was based primarily on the far earlier appearance in the Pleistocene of anatomically modern fossils. Current work in England with the fluorine method of dating has shown that several of the key specimens of presumed early modern man (Galley Hill, Baker's Hole, Piltdown, and possibly the London skull) are far more recent than was hitherto believed (Oakley, '50; Oakley and Hoskins, '50; Oakley and Montagu, '49). The great impor-

tance of these new dates cannot be overstressed. The evidence for the appearance of modern man before the Third Interglacial has been largely removed; it is more likely that he was a late arrival in the Pleistocene. Since it now appears that some Neanderthal fossils may be earlier than modern man, it becomes of prime importance to reexamine carefully these hominids which may have been the actual ancestral strain leading to modern man. Even before the fluorine redatings, such a study was recognized by LeGros Clark ('46) to be one of the "immediate problems of human palaeontology."

The Neanderthal group is complex, extending over considerable time and space. Since there is both regional and temporal diversity among the fossils called Neanderthal, it is necessary to reexamine the category before comparing it in detail to earlier and later groups of man. This problem was pointed out by Weidenreich ('43b) who noted that originally "the term Neanderthal man or Neanderthaloids was applied to the skulls of Neanderthal, Spy, La Chappelle-aux-Saints, Gibraltar, La Quina, Le Moustier and Krapina; or in other words to fossil hominids with certain features with their occurrence restricted to Europe." This is the general category which Hooton ('46) has termed "classic" Neanderthal.

As Kroeber ('48) rightly points out, earlier warm faunas and differing archaeological contexts with additional fossil material discovered in the past 25 years makes the earlier equation "Neanderthal = Mousterian = Würm," an inadequate description of the facts. Zeuner's ('40) summary of the geological and archaeological evidence for the dating of this material indicates that, for those specimens to which the term "Neanderthal" is customarily applied (see above), the majority are of early Fourth Glacial (Würm I) date (Spy, La-Chapelle, La Quina, La Ferrassie, and perhaps Le Moustier), whereas the Krapina fossils are from the preceding Third Interglacial (Riss-Würm) period. The early finds from Gibraltar and Düsseldorf (Neanderthal) can be assigned no definite date. Of the other, more recently found Neanderthal

material, only the Monte Circeo skull from Italy can be referred to the Fourth Glacial; the majority of the specimens (Galilee, Mount Carmel, Ehringsdorf, and Saccopastore) are from the earlier Third Interglacial. The Steinheim skull may be of either late Third Glacial (Riss) or Third Interglacial date.

Forms called Neanderthal span roughly a 100,000 years and in geographical distribution extend from western Europe as far east as Central Asia (including the Teshik Tash child; see Debetz, '40; Weidenreich, '45). Specimens restricted to peripheral western Europe (Monte Circeo and Gibraltar being found as far south as central Italy and the rock of Gibraltar) are of early Fourth Glacial date, whereas those of the preceding Third Interglacial occur further eastward.

With such considerable spatial and temporal distribution, one would suspect a similar morphological diversity, perhaps correlated with the range in space and time. Morant ('27) in his survey of the Neanderthal material found the group "remarkably homogeneous," but only a year later Stolyhwo ('28, also '37) questioned such conclusions as did Weidenreich ('28) in describing the Ehringsdorf cranium. Other workers (Hrdlička, '30; McCown and Keith, '39; Sergi, '44, '48b) have recognized subdivisions of the Neanderthal assemblage and with the later discoveries the tendency to subdivide the Neanderthals has become general. There has been, however, no comprehensive study comparable to that of Morant made almost 25 years ago.

The purpose of this paper will be the clarification of the differences among the Neanderthal fossils in order to reopen the question of their position in human phylogeny.

This study has been aided by a grant from the Viking Fund. Doctor S. L. Washburn has offered most helpful advice and guidance. The writer would like to acknowledge the help and courtesy of various others who have aided, directly or indirectly, in the preparation of this paper. The late Dr. Franz Weidenreich suggested the undertaking. Doctor H. L. Shapiro

allowed the writer to examine certain casts in the American Museum of Natural History, and Dr. T. D. Stewart offered assistance in obtaining the report on the Teshik Tash child and provided photographs of the cast of that specimen in the U. S. National Museum.

MATERIAL AND METHODS

The present study is based upon the skulls and mandibles (where preserved) of 10 adults and 2 juveniles of the interglacial Riss-Würm Neanderthals (hereafter designated early Neanderthals), and 7 adults, 1 adolescent, and 3 juveniles of the western European Würm I Neanderthals (hereafter designated classic Neanderthals). The data have been of necessity taken from the very vast literature on the Neanderthal fossils, descriptions of which are in large part thorough and adequate. Unfortunately casts were available to me for only a few of the specimens. Some fossils which might have been included, i.e., the Kafzeh remains (cf. Boule and Vallois, '46) which appear to resemble the Mount Carmel material, the La Ferrassie fossils and the Pech de l'Aze child's skull (Capitan and Peyrony, '10) of classical Neanderthal type, have never been described. The Podbaba cranium found near Prague and the Podkournok frontal bone found in the northern Caucasus are morphologically remains of modern man (Matiegka, '24; Hančar, '41). The specimens are listed in table 1 with data on provenience, state of preservation, and descriptive literature.

Comparison of the means for various measurements between the early and classic Neanderthal groups is an unsatisfactory procedure because of the small series available and the necessity for allowing for sexual differences. Of 7 classic Neanderthal adult skulls 5 are probably male; of the 9 early Neanderthal adults probably 6 are male. This discrepancy in sample proportions has a noticeable influence on the material results. Thus, comparison must be made between individual skulls of the same sex. Table 2 indicates the manner in which such comparisons have been made.

TABLE 1

Juvenile and adult Neanderthal crania with data on provenience, state of preservation, and principal literature

11. Skhül IV	Skhül cave, Mount Carmel, Palestine	♂	sphenoid, most of face	McCown and Keith ('39)
12. Skhül V	Skhül cave, Mount Carmel, Palestine	♂	Nearly complete skull with face, base broken	
			Nearly complete skull, defects in nasal region and middle face	McCown and Keith ('39)
13. Skhül IX	Skhül cave, Mount Carmel, Palestine	♂	Broken skull lacking much of rt. fronto-facial region, rt. wall of vault and face	McCown and Keith ('39)
14. Spy I	Rock shelter, near Dinant, Belgium	♀	Skull vault, portion of right maxilla	Fraipont and Lohest (1887), Klaatsch ('02)
15. Spy II	Rock shelter, near Dinant, Belgium	♀	Skull vault, two portions of maxillae	Fraipont and Lohest (1887), Klaatsch ('02)
16. Steinheim	Gravel pit, 30 km north of Stuttgart, Germany	♀	Skull with broken left facial and sphenoparietal regions	Berckheimer ('33), Weinert ('36)
17. Tabūn I	Tabūn cave, Mount Carmel, Palestine		Crushed skull vault, partially preserved face	McCown and Keith ('39)

The following discussion is confined to the evidence afforded by the Neanderthal crania, although the writer feels that the conclusions reached here would be strengthened by a study of the postcranial material. Comparison will be made between the specimens of the early and classic Neanderthal groups in order to determine the homogeneity of the entire Neanderthal assemblage. An attempt will be made to correlate morphological distinctions with the temporal and spatial distribution of the Neanderthal fossils. A comparison

TABLE 2

Method used for comparing adult specimens in the two Neanderthal groups

EARLY NEANDERTHALS	CLASSIC NEANDERTHALS
<i>Males</i>	
<i>Females</i>	

¹Indicates sex is based on postcranial bones (including pelvic bones for La Chapelle, Neanderthal, Tabün I, Skhül IV, V, IX) as well as the evidence afforded by the skull.

of the cranial vault and its several elements and the facial skeletons of the two groups is followed by a discussion of the relationships of the two groups to one another and to modern man.

NEANDERTHAL MORPHOLOGY

Morant's ('27) study of Neanderthal skulls presented conclusions based almost exclusively on western European classic Neanderthals; only one or two measurements were possible on the Krapina and Galilee material, these being too frag-

mentary. From a comparison of classic Neanderthal skulls to those of modern man, Morant concluded that the Neanderthals had the following characteristics: greater maximum and basilar lengths; greater widths; "peculiarly small" sagittal arcs relative to their great lengths; "peculiarly rounded" occipital bones; distinctly larger facial skeletons, relatively small orbits, and with "upper facial height being peculiarly great in proportion to all facial breadths."

Since Morant's study, only one specimen referable to the first part of the Würm glaciation has been discovered, the Monte Circeo skull from Italy. Though not as yet completely described, a preliminary article by Sergi ('40) shows it to be very like the other Würm I classic specimens.

The earlier Neanderthals differ from the later classic specimens both in distribution and morphology, as has been noted by Keith ('27), Weidenreich ('28), Weinert ('36), McCown and Keith ('39), and Sergi ('44, '48a, b). The early Neanderthals have shorter maximum and basilar lengths; narrower widths; more highly arched vaults; generally well-expanded occipital bones; proportionately smaller facial skeletons and smaller orbital and nasal apertures. Further distinctions will be brought out in the following discussion of Neanderthal cranial morphology.

The early Neanderthals are a shorter-skulled group (mean 194 mm) than the later classic Neanderthals (mean 201 mm). A comparison of individual skulls reveals that heavier supra-orbital tori were present in the early Neanderthals, although the differences are not especially marked. On the other hand, total thickness of frontal and occipital bone is the same as indicated by differences between inner and outer skull lengths. Thus, the early Neanderthals while having heavier supra-orbital tori, and occipital bones equally as thick as the classic specimens, have shorter skulls than the latter so that the long classic Neanderthal skulls cannot be attributed to more robust cranial bones. Similarly, the total distance between nasion and opisthion (Weidenreich's base line of the calvarium) is def-

initely less in the early Neanderthals compared with the three classic male specimens with the base preserved, even allowing for possible error in Boule's ('11-'13) reconstruction of La-Chapelle (Sergi, '40, etc.). The early Neanderthal females (Tabūn I, Saccopastore, Steinheim) were also shorter-skulled than the only classic Neanderthal (Gibraltar) female available (table 3).

The early Neanderthals have narrower as well as shorter skulls compared with the later classic Neanderthals in whom a markedly broad skull, such as is "only found for markedly brachycephalic modern races" (Morant, '27), is coupled with the great skull length. This is not only true for the maximum cranial breadth but appears to be the case for the greatest and least frontal breadths as well, although here the differences are slight. Thus, there is not only a difference in the lateral expansion of the parietal but similar, though less discrete, distinctions in the transverse diameters of the frontal in the region of the temporal lines and the post-orbital constriction.

A tendency for greater skull height in the early Neanderthals is revealed by a comparison of the individual values (auriculo-bregmatic). All of the females of the early group have higher values than the only female (Gibraltar) for which data are available for the classic Neanderthals; the early male Neanderthals have higher skulls (range 112-121) than do the classic Neanderthal males (range 110-116), although there is some overlapping of the ranges.

Higher values in the lengths of the total sagittal arcs, a composite of skull length and height, occur in the early Neanderthal fossils. The difference seems to be largely in the parietal, which tends to be more expanded in the early Neanderthals. There may be differences in the occipital arc values as well, but lack of material makes this uncertain. Arc values for the occipital are somewhat larger in the early Neanderthals than in the one best-preserved specimen (La Chapelle) of the classic group (mid-sagittal sections of the Monte Circeo

TABLE 3
Measurements of the Neanderthal vault: lengths, breadths, height

SPECIMENS	SEX	LENGTHS				BREADTHS			AURIC.- BREG.
		Max.	Inner Skull	Max. Inner Skull	Nas.- Opisth.	Max.	Least Front.	Max. Front.	
Ehringsdorf II	♂	196	171	25	141	145	113	121	121
Gählee	♂	97	113	..
Skhul IV	♂	(206)	(176)	(30)	158	148	(106)	113	112
Skhul V	♂	(192)	(167)	(25)	136	143	99	114	121
Skhul IX	♂	(213)	(187)	(26)	..	145	96	(120)	117
Saccopastore I	♀	181-2†	..	..	135	142	101	116	113
Steinheim	♀	184	156	28	(137)	132-33	102	118-19	101
Tabun I	♀	183	161	22	142	(141)	98	(122)	98
Means and Range		194 (181-213)	158 (156-187)	(22-30)	142 (135-158)	142 (132-148)	102 (96-113)	119 (113-122)	109 (98-121)
La Chapelle	♂	208	186	22	171	156	109	122	111
La Quina H5	♂	204	..	..	..	138	100	108†	122
Monte Circeo I	♂	204	..	..	156†	155	106†	123	110
Neanderthal	♂	199	175	24	..	(147)	107	122	..
Spy I	♂	202	..	..	..	144†	101	..	116
Spy II	♀	200†	..	..	..	153	108	126	..
Gibraltar I	♀	190	163	27	149	(146)	107	(125)	(93)
Means and Range		201 (190-208)	175 (163-186)	(22-27)	159 (149-171)	148 (138-156)	105 (100-109)	121 (108-126)	108 (93-116)
Engis no. 2	♂	188	..	..	114	131	71	114	130
Gibraltar II	♂	150†	104†	125	..
Le Moustier	♂	196	176	20	159†	150	109	120†	111
Teshik Tash	♂	185	..	..	141	144	101	120	113
La Quina H18	♀	171	..	..	127†	132	88	109	(99)
Skhul I	♀	(167)	(163)	(04)	130†	121	(84)	(100)	(101)

specimen show, however, that the occipital was quite similar to La Chapelle and also to La Quina H5, in all of which there may have been comparable arc values for this bone). There is apparently no clear difference between the values for the frontal bones (table 4).

The early Neanderthals, although shorter-skulled than the classic specimens, tend to have longer median sagittal arcs and these are further detectable in the individual parietal and (probably) occipital vault elements. At least for the frontal and parietal bones there are scarcely noticeable distinctions between the two groups for curvature indices of these bones. The better arched cranial vaults of the early Neanderthals are not the result of the curvature of these bones but are due to another factor, the orientation of the vault elements with reference to one another.

This is brought out in the inclination of the frontal and occipital bones measured with reference to the maximum skull length (glabella-opisthocranion line). The more erect orientation of the early Neanderthal frontal (mean 53° , range 47° – 56° , with only the Tabūn specimen having a value as low as those of the classic specimens) is obvious when comparison is made with the values for the classic Neanderthal fossils (mean 45° , range 39° – 50°). Similarly, the upwardly, and posteriorly expanded occipital squama in the early group (mean 74° , range 71° – 81° , excluding only the Ehringsdorf II specimen with the low value of 63°) contrasts markedly with the more sharply angulated classic Neanderthal occipital (mean 65° , range 59° – 69°).

The cranial base is more flexed in the early Neanderthal specimens than in the later classic Neanderthals as Sergi ('48d) has recently pointed out. Thus, Landzert's sphenoidal angle, formed by the junction of the clival axis with the ethmoidal plane, exhibits greater flexion in the early Neanderthals (range 101° – 117°) than in the classic specimens (range 123° – 135°).

The deflection and consequent shortening of the cranial base has, as Weidenreich ('41) pointed out, a profound influence

TABLE 4
Measurements of the Neanderthal vault: cranial arcs and angles

SPECIMENS	SEX	CRANIAL ARCS				CRANIAL ANGLES			
		Med. sag.	Nas.- breg.	Breg.- lamb.	Lamb.- opisth.	Front. inclin.	Occip.- inclin.	Occip.- curv.	Landz.- sphen.
Ehringsdorf II	♂	380	135	128	117	52°	63°	107°	..
Galilee	♂	..	125	..	..	..	..	..	..
Skhul IV	♂	(403)	(132)	..	..	55°	81°	118-19°	..
Skhul V	♂	373	118	131	124	56°	71°	115°	117.5°
Skhul IX	♂	(379)	(130)	120	(129)	53°	77°	..	..
Sacopastore II	♂	101-05°
Sacopastore I	♂	338?	110?	121	107	52°	..	102°-09°	103°?
Steinheim	♂	431-42	120	107-09	..	54°	76°	112°	..
Tabun I	♂	(333)	107	117	(108)	47°	74°	120°	..
Means and Range	♂+♂+♂+♂+♂+♂	364 (333-403)	122 (107-135)	123 (107-134)	118 (107-129)	53° (47°-56°)	74° (63°-81°)	114° (107°-20°)	..
La Chapelle	♂	357	121	121	115	46°	64°	111°	135°
La Quina H5	♂	..	120	112	..	39°	59°	..	..
Monte Circeo I	♂	(361)?	131	117	..	43°?	68°?	117°	134°
Neanderthal	♂	..	133	110	..	46°	69°	..	..
Spy I	♂	..	110?	126	..	50°	67°	..	..
Spy II	♂	115	..	..	..	..	..
Gibraltar I	♂	(342)	(124)	..	106	..	64°	110°	123°
Means and Range	♂+♂+♂+♂+♂+♂	353 (342-361)	123 (110-133)	117 (110-126)	111 (106-115)	45° (39°-50°)	65° (59°-69°)	113° (110-17°)	..
Engis no. 2	♂	336	118	113	105	54°	73°	111°	..
Gibraltar II	♂	..	116	110	..	..	..	..	..
Le Moustier	♂	(346)	122	121	(103)	51°	74°	124°	..
Teshik Tash	♂	363	120	111	123	58°	73°	119°	..
La Quina H18	♀	..	108?	99?	..	50°	76°	..	..
Skhul I	♀	(331)	(112)	114	105	65°	83°	115°	..

on the shape of the vault, for it causes "the expansion of the brain case in dorsal and anterior direction." This is a condition clearly present in the early Neanderthals. In the later classic Neanderthals, on the other hand, the less sharply angulated cranial base predisposes an elongation of the entire cranial vault with a resultant lack of height and decreased angulation of the frontal and occipital vault elements. This is illustrated in figure 1 showing mid-sagittal sections of an early (Skhül V) and classic (Monte Circeo I) Neanderthal skull.

Thus, Morant's ('27) statement that the marked Neanderthal vault flattening relegates "the Mousterian skulls to positions which are entirely outside the inter-racial distributions for modern man" is applicable only to the classic fossils. A further statement that the "Neanderthaloid skulls are apparently distinguished from all modern types by having a greater transverse flattening of the vault, more vertical walls and a height that is peculiarly small in proportion to the breadth" is also true only for the later classic Neanderthals. Marked post-lambdoidal flattening appears a peculiarity of the classic forms and is not evident in any of the early specimens.

These differences are already present and equally well-marked in the juvenile specimens of the two groups. The low, rounded outlines of Engis no. 2, La Quina H18 and Le Moustier are clearly distinct from the higher, more laterally expanded vaults of the Skhül I and Teshik Tash children. The sagittal contours of the Engis (Fraipont, '36) and La Quina (Martin, '26) children already exhibit the characteristic post-lambdoidal flattening found in the adult classic Neanderthal specimens. The differences noted between the early and classic Neanderthals are thus not adult peculiarities but are manifest in the young individuals as well and are evidence of different patterns of growth operative in the two groups. Much valuable information could be gained from a comparative study of the juvenile specimens of the two Neanderthal groups and the growth pattern in modern man.

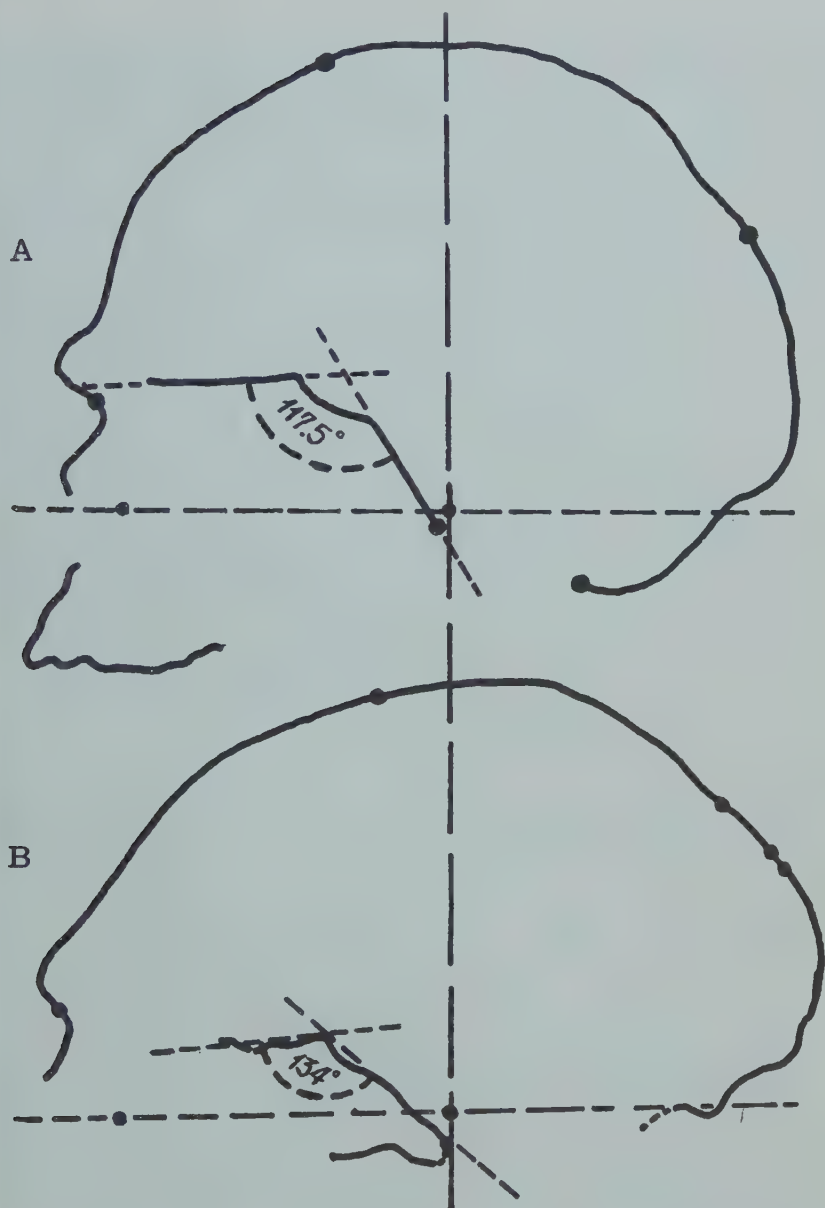


Fig. 1 Mid-sagittal craniograms of (A) an early Neanderthal (Skhul V) and (B) a classic Neanderthal (Monte Circeo I) illustrating differences in the length and flexion of the base and contours of the vault (after McCown and Keith, '39; Sergi, '48d). $\frac{1}{2}$ nat. size.

There are differences in the form of the torus occipitalis in the two Neanderthal groups as Weidenreich ('40) noted (although he did not make the same distinctions as the writer does here). This structure would appear to be related to the curvature of the occipital bone, at least from the tentative evidence available here. Where there is an expanded occiput as in the early Neanderthals, the torus is a rather unimportant structure, and though relatively long in its lateral extent, it is not robust and may often be slight; there is a tendency for an incipient inion to appear, a supratotal pit being either small or scarcely noticeable.

In 5 skulls (Skhūl IV, V, IX, Tabūn, and Saccopastore I) of the early Neanderthal group there is a developed or incipient external occipital protuberance (inion) with a supratotal pit being small or ill-defined. In Steinheim there is a very low "palpable rather than visible" (Weidenreich, '40) structure, somewhat flattened medially with a very minute supratotal sulcus. Ehringsdorf II, in its occipital curvature like the classic Neanderthals, is also similar with respect to total formation. McCown and Keith ('39) report that the "inion is indicated by a T-shaped ridge or elevation" in the Skhūl child, but they mention no torus occipitalis and none is visible in their illustrations of the specimen. A small torus is present in the Teshik Tash child, its exact form being uncertain due to breakage in this area.

Where there is fairly sharp angulation of the occipital, as in the early Ehringsdorf II specimen and in the later classic Neanderthals, the torus occipitalis is a broad robust structure separating the squamous portion of the occipital (where a noticeable supratotal pit or sulcus appears) from the nuchal area. The total formation of the classic Neanderthals is, in the adult forms, generally tripartite, two lateral elevations joined medially by a more flattened bony bridge which may be either fairly narrow (Neanderthal, Spy I, La Chapelle) or somewhat broadened (Spy II, La Quina, Monte Circeo I). Only in the Gibraltar I skull is there seen a different condition,

this specimen "does not show a distinct torus occipitalis but the nuchal plane is demarcated by a sharp superior nuchal line, such as is usually combined with the existence of a real torus" (Weidenreich, '40). Fraipont ('36) states that the torus occipitalis is already present in the 6-to-7-year-old Engis child but this is scarcely visible in photographs and appears to have been diminutive. The La Quina H18 child of about the same age shows a scarcely visible torus for, as Martin ('26) states, it is "only indicated." Above the torus in the adult classic specimens is a marked supratotal pit or fossa, either very elongate (as in Spy I, II, La Quina H5) or more limited (La Chapelle, Monte Circeo I), sometimes being only a small pit (Gibraltar I).

Whether the torus occipitalis is a structure related to the nuchal musculature (especially *Semispinalis* ?) (McCown and Keith, '39) or is part of a more general reënforcement complex and is "an intrinsic element of the post-otic region of the cranium which evidently serves to reënforce its framework at the boundary between the base and the vault" (Weidenreich, '40) is not altogether clear at present. If the torus is related to the conformation of the occipital bone and its angulation, then Weidenreich may well be correct. On the other hand, there may be associated differences in musculature and the views of McCown and Keith favor a factor which is part of an occipital complex involving nuchal musculature, angulation of the occipital bone and relationship of the occipital to other elements of the vault.

There are certain differences in the temporal regions of the early and classic Neanderthals, perhaps related to other differences already noted in the specimens. In the early Neanderthals the external auditory meatus tends to have a vertically elliptic form whereas in the classic Neanderthals the aperture is round or horizontally elliptic. Although there is some variability in this feature, e.g., Ehringsdorf II having a horizontally elliptic shape, the majority of the earlier group are distinguished from the later classic fossils.

Related to this distinction in the auditory aperture is an associated difference in the configuration of the tympanic plate. This has been noted especially in the early forms by McCown and Keith ('39), who point out that in the Mount Carmel population "the prevailing characters are Neanthropic." In all the Neanderthal material a vaginal ridge divides the tympanic plate into anterior and posterior portions but there is a noticeable difference in the earlier group in which the posterior portion of the tympanic plate is reduced, while in the classic forms it is instead as large as the anterior. Similarly, the horizontally oriented tympanic of the classic Neanderthal type contrasts markedly with the vertically or obliquely directed anterior tympanic portion in the early Neanderthals, in which this portion serves to form in large part the posterior wall of the glenoid fossa (fig. 2).

McCown and Keith ('39) point out that "in the size and shape of the posterior area of the tympanic plate, the Carmel child (Skhül I) on the whole resembled modern rather than Neanderthal man." The auditory aperture of the Teshik Tash child is somewhat broken but it can be seen that there was an oblique anterior portion and a rather heavy posterior part more horizontally directed. In the Gibraltar II and La Quina H18 children of the classic group, the anterior and posterior parts of the tympanic plate are clearly separated by a heavy vaginal ridge, the aperture being horizontally elliptic or round.

There is no discussion in the literature regarding the angulation of the tympanic bone with the pyramid in the Neanderthal specimens, except for a brief statement by Weidenreich ('43b) that "the Neanderthals show the conditions of the modern human type" (he fails to state to which specimens this applies and from photographs and drawings in the literature there would appear to be distinctions but these are not described). If the shortening and flexing of the base affects the petro-tympanic angulation (as Weidenreich suggests), then differences would be expected in this region between the two

Neanderthal groups. Weidenreich points out that during the course of evolution the pyramid becomes shortened and "turns in a more transverse direction" so that "axes drawn in transverse direction through the tympanic plate and the pyramid" in modern man "form a more or less straight line." Whether there were differences between the early and classic Neanderthals is, as mentioned before, uncertain and study of the original specimens is needed to clarify this point.

Weidenreich further points out that there are probably related changes in the orientation of the tympanic plate

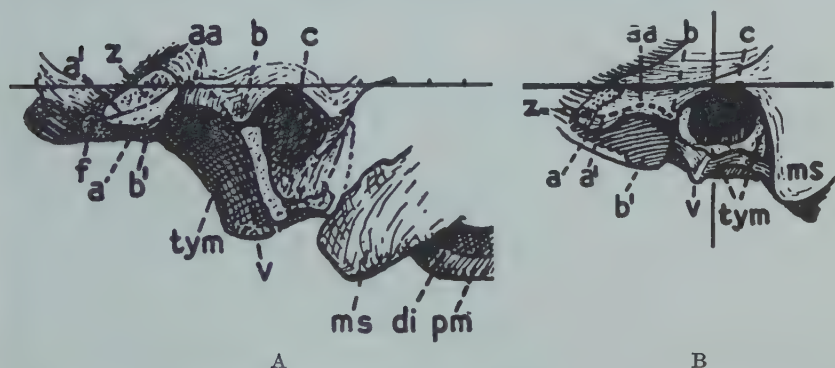


Fig. 2 Lateral aspects of the temporo-mandibular region of early Neanderthal (Skhul IV, left) and (B) a classic Neanderthal (Gibraltar I, right) (after McCown and Keith, '39; courtesy Oxford University Press).

accompanying alteration in orientation of the tympanic and pyramid, stating that "the originally horizontally oriented tympanic plate undergoes a rotation and stands vertically." Such differences have already been noted in the two Neanderthal groups, there being in the earlier specimens a more vertical position of this bone.

A number of characters would appear to be related to the shortening and flexion of the cranial base. This has already been noted with respect to the orientation of the frontal and occipital bones and the angulation of the occipital. Changes in the cranial base would also seem to affect the petrous pyra-

mids and perhaps the orientation of the adjoining tympanic. Thus, where the base is less markedly flexed there is a sharper angle between the opposing pyramids, angulation of the petro-tympanic axis, and perhaps more horizontal orientation of the tympanic plate. With shortening and flexion of the base there is antero-posterior compression which brings the petrous pyramids to a more obtuse angulation, and thereby more in line with the tympanic, the latter structure becoming more vertically directed. Several elements of the cranial base and the temporal bone may thus be related, although no study as yet has been directed towards clarifying this very complex problem.

The intermediate position of the cranial base between vault and facial skeleton is again important in that greater flexion of the base will affect the face as well as the brain case. This has been discussed at length by Weidenreich ('41, '43b), and much earlier by Virchow and Ranke (cited by Weidenreich). The facial triangle will have one of its sides, the deep facial line from nasion to basion, affected by the cranial base which is that side. The other sides of the triangle are not simple units but are each composed of several separate elements. For example, superior facial length (basion-prosthion) comprises the maxillaries, the palatines, the pterygoids, and to a considerable degree, the base. In a similar fashion, the measurement of upper facial height (nasion-prosthion) includes several bony elements and is equally complex. Similarities in measurements of the facial triangle may be due to a number of factors which, because of the several elements included in the measurements, are not immediately revealed. Facial measurements as employed here are intended to give only a rough estimate of differences in the Neanderthal facial skeleton and no attempt is made to differentiate further the several factors which may bring about such differences since these are not available in the literature and indeed little work of any kind has been done in this direction.

There is a tendency to smaller faces in the early Neanderthals, as determined by the lengths of the facial triangle, and these may be correlated with the difference in basal flexion. The classic forms have not only larger facial skeletons but greater orbital and nasal heights than the earlier forms. There is overlapping of most of the facial breadths for the two Neanderthal groups, except for orbital and nasal widths which have a slight tendency to be larger in the later classic specimens. In Morant's ('27) study, as well as in the larger series dealt with here, "the very similar nasal, alveolar and basal angles — are very close to the mean for all modern races" and the early and classic groups fail to separate one from another (table 5).

Characteristic of all the Neanderthal skulls is the development of heavy brow ridges. These are of two major types, each being associated with one of the two groups. In the early forms, the primary distinctions are in the tendency to differentiate ciliary and orbital portions of the torus, and the straight rather than curved shape of the two tori which appear as a transverse bar across the superior margin of the orbit. In the separation of the medial and lateral elements a groove appears, extending from the region of the supraorbital notch obliquely upwards and laterally (Schwalbe's, '01, *sulcus supraorbitalis*).

Due to the broken condition of this region in the Ehringsdorf II skull, Weidenreich ('28) was uncertain as to the presence of a sulcus separating medial and lateral elements of the torus; he suggests that such appears and from photographs in his report there would seem to be a slight furrow corresponding to the sulcus, but it is not as evident as in the Skhul material from Palestine. The broken condition of the Steinheim supraorbital region makes it difficult to determine the original shape of this area but it would appear to have been similar to the Skhul material, although there was probably no clear separation of medial and lateral elements. There is no adequate description of this region in the literature and

TABLE 5
Measurements of the Neanderthal facial skeleton

SPECIMENS	SEX	ANGLES AND LENGTHS OF THE FACIAL TRIANGLE					ORBITAL AND NASAL APERTURES				
		Nasion angle	Prosth. angle	Basion angle	Basilar length	Sup. Fac. length	Sup. Fac. height	Orbital breadth	Orbital height	Nasal breadth	Nasal height
Galilee	♂	63°	70°	47°	(110)	(105)	(79)	44	37	..	..
Skhul IV	♂	81°	59°	40°	100	115	73	(44)	(34)	30	55
Skhul V	♂	63°	78°	40°	(115)	(106)	(74)	46	30	28	53
Skhul IX	♂	70°	66°	44°	114	117	87	(44)	37	(30)	(55)
Saccopastore II	♀	75°	60°	46°	102	(114)	86	49	38-39	34	59-60
Saccopastore I	♀	74°	65°	42°	99-100	107	74-75	46-47	39½	31	59
Steinheim	♀	60°	78°	42°	(108)	(102)	79	41½	30	30½	52
Tabun I	♀	69°	68°	43°	107	109	79	(42)	(33)	(34)	(58)
Means and Range		(60°-81°)	(59°-78°)	(40°-47°)	(100-115)	(102-117)	(73-87)	45	35	31	56
								(41-49)	(30-39)	(28-34)	(52-60)
La Chapelle	♂	70°	68°	42°	125	125	86	47	37	34	61
Monte Circeo I	♂	71°	70°	45°	(116)	(115)	(87)	49	37	36	66
Gibraltar I	♀	67°	72°	41°	106	108	79	46	39	35	59
Means and Range		69°	70°	43°	116	116	84	47	38	35	62
		(67°-71°)	(68°-72°)	(41°-45°)	(106-125)	(108-125)	(79-87)	(46-49)	(37-39)	(34-36)	(59-66)
Le Moustier	♂	61°	71°	37°	124	125	80	42	42	28½	..
Teshik Tash	♂	67°	73°	41°	96	93	65	37	33	29	44
La Quina H18	♀	62°	82°	37°	95	84	58	34½	32½	23	45
Skhul I	♀	68°	74°	37°	(85)	(83)	(48)	..	..	..	..

from photographs and casts it is difficult to determine the actual extent of distortion due to earth compression.

The Tabūn suprafacial tori (early Neanderthal) are more like those found in the classic Neanderthal material. Here, above each superior orbital margin, a semi-circular bony formation extends medially from the zygomatic process of the frontal to the glabellar region where right and left bone semi-circles are linked by a raised bony bridge. There is no splitting of the torus into medial and lateral elements as in the early Neanderthals but rather it is one solid element. This type constantly occurs in the classic Neanderthal group; even in the La Quina H18 and Gibraltar II children the formation is clearly evident, although lacking the robust form seen in the adults. That this feature is similarly developed in the Engis child's skull is one of several reasons for assigning this specimen to the classic group.

This structure is what Schwalbe ('01) termed *torus supraorbitalis* or Cunningham's type III (Cunningham, '04) of suprafacial torus. In terms of the structures generally present in modern man, there is a fusion of supraorbital (lateral) and supraciliary (medial) elements into arcs, these being united at the glabellar region. The *trigonum supraorbitale*, in modern man a depressed triangular area formed laterally by the inferior extension of the supraorbital arc, is fused with the latter to extend the entire arch as far as the fronto-malar suture.

In the early forms, the formation is that which Cunningham has depicted as transitional between his Types II and III (cf. his plate III, fig. 24 illustrating the condition in an Australian adult). The lateral and medial elements in the early Neanderthal suprafacial torus are like the heavy ridges seen among some Australian and Tasmanian skulls. The structures appear early as they do in the classic Neanderthal group (but in a different fashion); McCown and Keith ('39) point out that the "medial (supraciliary) as well as the lateral (supraorbital) elements are already recognizable" in

the Skhül I child (aged about 4 to 5 years) but are clearly separate and quite distinct from the condition in the young classic specimens.

The morphology of the lower face is similarly different in the two Neanderthal groups, these distinctions concerning the malar and maxillary bones and their relationships to one another. In the early Neanderthals, possibly including the broken Krapina specimens, the body of the malar is large with sharp demarcation between malar and maxilla, and a definite tendency for formation of a canine fossa. In the classic Neanderthals, the small malar body grades smoothly into the maxilla with lack of sharp demarcation between the two, no sharply defined inferior malar margin (and thus the alveolozygomatic pillar courses obliquely postero-superiorly rather than vertically as in the early forms), and lack of development of a canine fossa.

The adult classic Neanderthal condition (known from La Chapelle, Gibraltar I, Monte Circeo I, and the La Ferrassie male specimen) is already evident in the juvenile fossils. This is well seen in the La Quina H18 child (Martin, '26) where the adult conformation is duplicated. That the eruption of the anterior permanent teeth have little effect on this region in the classic fossils may be seen in the La Quina child (where the permanent incisors have nearly completed eruption) and in the Gibraltar II maxillary fragment in which is found "a form entirely comparable with the Forbes Quarry (Gibraltar I) skull. The zygomatic process is directed outwards and backwards. There is no canine fossa . . ." (Buxton, '28). In the maxillary bones, as in other portions of the classic Neanderthal skull already considered, the adult conformation is clearly indicated in the juvenile specimens, suggesting that these differences are not adult peculiarities but are the result of a distinctive developmental pattern.

As Sergi ('48c) points out, sagittal, horizontal, and transverse curvatures of the maxillary region make up the more accentuated depression which forms the canine fossa. In the

Steinheim skull (Berckhemer, '37) all these are present; in the Saccopastore specimens the condition is similar but the maxillary wall is slightly less hollowed, there being partial maxillary inflation. Skhül IV is rather like Steinheim although not so fully developed in a sagittal direction, while Skhül V, though probably not unlike Skhül IV, is difficult to interpret due to the broken condition of the face. The classic Neanderthal maxillary lacks these curvatures as Sergi (op. cit.) has pointed out and instead the maxillary forms a flattened plane, inflated or blown out compared to the condition in modern man and the early Neanderthals (Sergi terms the classic Neanderthal condition *oncognatic*). Thus, the maxillary walls converge, "projecting in a way to form together a cone" when viewed from the base (Sergi terms this *sphenoprosopia*).

Seipel ('48) has pointed out that in modern man the canine fossa is a relatively unstressed area composed of fairly thin bone. This suggests that the maxillary conformation of the classic Neanderthals may have been more highly stressed with a different trajectorial system than that of modern man (and the early Neanderthals). Thus, the classic Neanderthal maxillary may have been more organized with antemolar trajectories coursing postero-superiorly into the malar region (Seipel illustrates this condition in a chimpanzee).

In those specimens where both the face and mandible are preserved (La Chapelle, La Ferrassie male, La Quina H5, Le Moustier, Skhül IV, Skhül V, Tabün I) it is perhaps possible to see a correlation between certain characters of the lateral facial region, that is, supraorbital and malar regions and the angle of the mandible. In the early Neanderthals, the robust lateral supraorbital tends to separate from the median supraciliary element, is oriented anteriorly and quite separate from the frontal squama and the anterior extent of the temporal fossa; the malar projects latero-anteriorly; and the gonial angles are acute. In the later classic Neanderthals, on the other hand, somewhat smaller lateral supraorbital elements (Stolyhwo, '27) fused with median supraciliaries form-

ing unbroken tori, are associated with small non-projecting malars shelving into maxillaries, and obtuse gonial angles (plate 1).

A possible explanation for these differences would be a relatively larger masseter muscle in the early Neanderthal group. This would account for the larger angle (insertion) and malar (origin) and, possibly, the greater development of the lateral brow ridge element. Such a condition is seen in some modern Mongoloid groups with acute, flaring gonial angles, jutting malars, and prominent lateral supraorbital elements.

As Seipel ('48) points out, "in the maxillary bone and the upper facial skeleton the dominating influence of the muscles of mastication upon the trajectorial and architectural arrangement is quite clear." The trajectorial pattern of the malar and its ascending frontal process indicates that the masseter muscle is of major importance in determining the conformation of this region, and that varying development of this masticatory muscle would doubtless be reflected in the structure and relationships of the upper and middle face. Thus, several features often regarded as morphological isolates are in fact part of a functional complex, and it is important that these characters be regarded as part of a pattern rather than separate and unrelated structures.

DISCUSSION

The differences described above may be briefly summarized as follows. The early Neanderthals are similar to modern man, and differ from the classic Neanderthals, in that they have: shorter cranial lengths, and narrower widths but laterally expanded walls; shortening and greater flexion of the cranial base with more highly arched vaults and expanded occipital bones with tendency to produce an external occipital protuberance associated with a small torus occipitalis; a tympanic plate with a vertically oriented anterior part and less robust posterior portion; smaller facial skeletons; a tendency to separate medial and lateral suprafacial toral elements;

more antero-lateral orientation of malar bones with clear demarcation between malar and maxilla and tendency for formation of a canine fossa.

Conversely, the classic Neanderthals differ from both the early Neanderthals and modern man in that they have: long, low and wide cranial vaults; less flexed cranial bases and more sharply angulated occipital bones with heavy occipital tori; more horizontal orientation of the tympanic plate with heavy anterior and posterior portions; large facial skeletons; semi-circular supraorbital tori with fused medial and lateral elements; shelving of maxillary into malar with no clear demarcation between these and lack of maxillary hollowing into a canine fossa. A number of these are peculiar to the group and may be correlated with the differences in the structure of the base and the masticatory musculature.

There are morphological distinctions between the skulls included in the general category Neanderthal man, and these distinctions are correlated with the original separation of the Neanderthal assemblage into Riss-Würm early Neanderthals and Würm I classic Neanderthals. Since the Neanderthals are then a morphologically as well as temporally heterogeneous assemblage, it is necessary in any phylogenetic discussion to consider the two groups separately, rather than the entire assemblage as a whole.

The presence of many modern features in the early Neanderthal crania is striking. This is most evident in the Mount Carmel population, especially the material from the Skhul cave, but it is also true for the Steinheim, Ehringsdorf, and Saccopastore specimens in which similar modern features occur, but with somewhat greater classic Neanderthal resemblances.

Not only do the classic Neanderthals differ from modern man and the early Neanderthals but they greatly resemble one another, as Morant ('27) pointed out. In many respects, the cranial morphology of this group appears as an exaggeration of conditions present in some of the earlier Neanderthal fos-

sils; the joining of supraorbital elements tending to be separate previously, the larger cranial lengths and low vaults with reduced basal flexion and perhaps resultant peculiar occipital morphology and alterations in the temporal region. As suggested previously, the different structure of the facial skeleton may be associated with differences in masseter musculature. There is little evidence to indicate that classic Neanderthal morphology is fundamentally primitive; it is rather, a pattern peculiar to, and distinctive of, a geographically isolated group.

The adult morphological pattern for both Neanderthal groups is established at an early age judging from the evidence available from the few juvenile specimens. There is no mistaking the characteristic morphological pattern of the adult classic Neanderthal as being already present in the children from Engis, Gibraltar and La Quina. Similarly, the early Neanderthal children from Skhūl and (probably) Teshik Tash exhibit features anticipating those of adult early Neanderthals from the same time level in the Near East. As in modern man, then (Brodie, '41), the particular pattern of growth is established early in ontogeny and apparently this "morphological pattern, once attained, does not change." These differences in the children provide further evidence for keeping the two Neanderthal groups separate, indicating the distinctive early and classic Neanderthal morphological patterns.

An examination of the early Neanderthal distribution reveals a definite morphological gradient extending from the Near East through central Europe as far as present western Germany. The more anatomically modern of the Third Interglacial forms occur in the Near East area, there being a tendency further westward for characters more like those of the classic Neanderthals to occur. In this regard, the classic Neanderthals of Würm I represent a further extension westward of the gradient and a step later in time.

The early Neanderthals known from the warm period preceding the first advance of the Würm glacial in western Europe

include Ehringsdorf from western Germany and the Saccopastore skulls from central Italy. Though sharing the general trend toward anatomically modern morphology seen in the other early Neanderthals further eastward, i.e., Krapina and Mount Carmel (included under the latter are Galilee, Teshik Tash and almost certainly the undescribed Kafzeh material), these forms were approaching the pattern later to be seen in the classic Neanderthals. What may have been the result of geographic variation originally, i.e. the gradual gradient westward, was much modified under the first advance of the Würm glaciation. To understand more fully what occurred at this time it is necessary to consider the effects of this glaciation.

The movement of the Scandinavian and Alpine ice masses cut off western Europe almost entirely from areas further eastward except for a corridor through northern Europe between the two glaciers. As at present, this corridor was subjected to severe continental climate. Such was also true for movement south into Spain where only the rugged western Pyrenees were ice-free. The Italian peninsula was nearly shut off from the Albanian coastal region, and thus eastern Europe, by the southward extent of the Alpine ice; only a narrow coastal strip linked the peninsula with westward areas (see Antevis, '29). All of western Europe including Spain and the Italian peninsula were peripheral areas, in large part isolated from regions further eastward (fig. 3).

It is within the confines of this area that all of the classic Neanderthals of Würm I have been discovered.¹ All known thus far exhibit the peculiar morphology discussed above. It is not inconceivable, and indeed appears highly probable, that isolation of western representatives of the early Neanderthal gradient for several tens of thousands of years in a rather

¹ The fragmentary left maxillary bone of a child, described by Şenyürek ('40), which he states "seems to belong to the species *Homo neanderthalensis*," probably extends the range as far as the Atlantic coast of present Morocco. In a later publication, Howe and Movius ('47) correlate the level in which the fossils were found as Würm I, thus of the same date as the other classic Neanderthals.

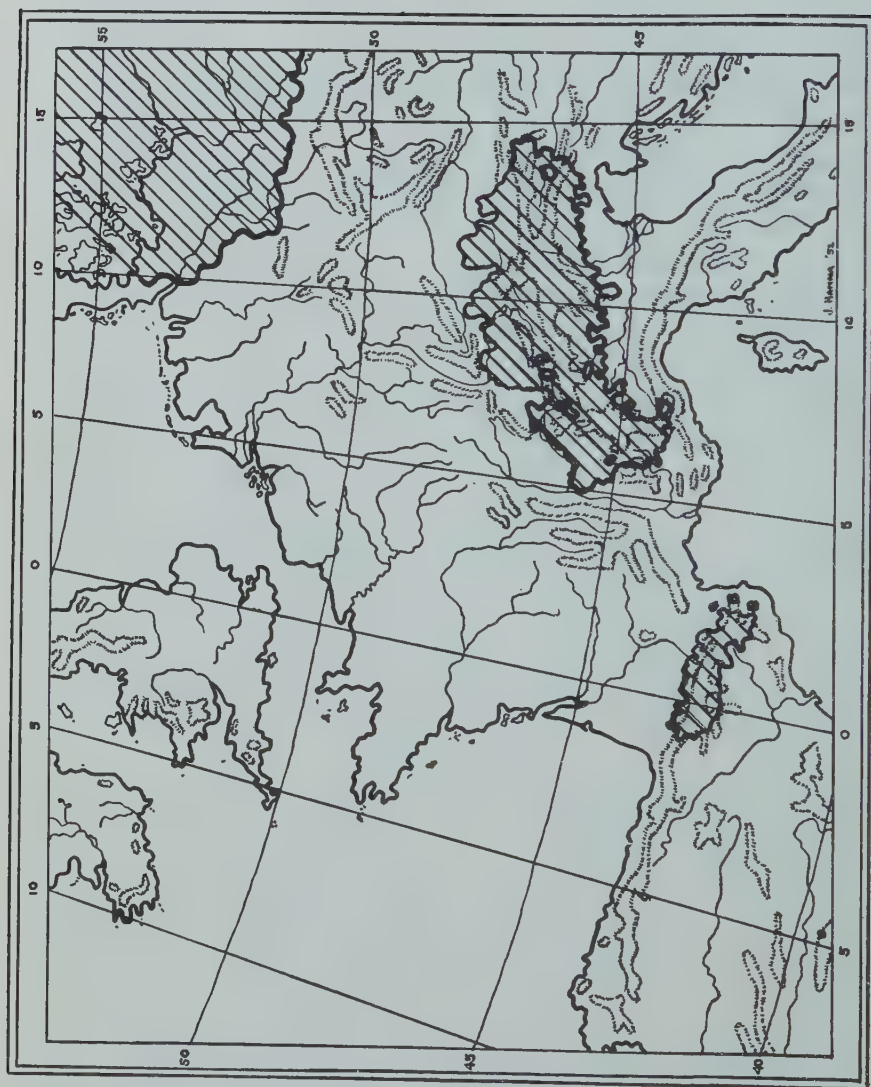


Fig. 3 Map of western Europe during maximum extent of the Würm I glacial in the Scandinavian, Alpine, and Pyrenean regions (based on data from Antevs, '29; Bull. Geol. Soc. Am., 40: 631-720).

limited area, and subjection to the rigors of an extreme arctic environment, would account for the appearance of the classic Neanderthal population. Under this environment, selection would be severe, chance for genetic drift at an optimum, and opportunities for migration reduced to a minimum. These multiple factors brought about a distinctive race of mankind occupying this area during Würm I.

Little is known thus far of Third Glacial (Riss) hominids from Europe which might be ancestral to the early Neanderthals; if Steinheim is of this period, as Zeuner ('40) suggests it may be, then at least the general type is known. This specimen indicates that certain features were already evolved in a modern direction (form of the occipital and lower face), the basic pattern being much like that of the other early Neanderthals. The marked similarity between the Swanscombe parieto-occipital fragment (LeGros Clark and others, '38), of late Second Interglacial or early Third Glacial provenience, and the later Steinheim skull would seem to indicate that this type was present even earlier. In view of the heavy supraorbital development of all early Neanderthals (and the possibly antecedent Steinheim fossil) as well as the earlier Asian prehominids, there is little reason to believe that the frontal morphology of Swanscombe was too different from other early Neanderthal specimens in this respect. The Fontéchevade skull (Vallois, '49) may be another fossil of the early Neanderthal group; its fragmentary condition makes reconstruction difficult but there is no strong evidence to preclude it being of this general type. It is important when making comparisons of such early material to utilize the early Neanderthal fossils and not the peculiar peripheral classic Neanderthals, which were probably a local divergent development in western Europe. When this is done the characters of Fontéchevade differ little from those of the early Neanderthals.

It is among the more eastern representatives of the early Neanderthal group that evolution was leading toward modern man. Thus, the Mount Carmel population (as just defined

previously) was in many respects practically at the modern level although a number of general morphological features linked this form to the other early Neanderthals. At present there are insufficient data to substantiate Montagu's ('40) view that this population was the result of hybridization since the new fluorine datings have largely removed evidence for the appearance of modern man earlier than the Mount Carmel population. Evidence is lacking in the Near East of hominids of equivalent Würm I age but the Kšar Ákil child (Ewing, '47) may well be a descendant of more modern peoples as yet undiscovered in these levels, the latter being the offspring of the transitional Mount Carmel population. There is also no indication that the classic Neanderthals of the western periphery continued after the recession of the first Würm stadial. Indeed, these forms are limited to Würm I insofar as known, whereas the first remains of modern man occur in the following interstadial deposits (Combe Capelle) and more abundantly in Würm II deposits. This would certainly suggest that these classic Neanderthals had either become extinct prior to, or were killed off by the arrival of, modern types from the more easterly European regions. Either may have been the case. Dobzhansky's ('44) suggestion that there may have been hybridization, based on the concept that hominids of this time were all one species, is well taken and is a possibility, but the evidence suggests that in western Europe there was a sharp break, evolution having taken place further eastward and that the classic Neanderthals were replaced by these forms.

Several interpretations of European hominid phylogeny are shown in figure 4. In figure 4 a, two parallel phylogenetic lines extend from lower to upper Pleistocene; one leading from the Heidelberg fossil through Steinheim-Ehringsdorf and the early Neanderthal group to terminate in an extinct classic Neanderthal group, the other leading to modern man through Galley Hill-Piltdown-Swanscombe-Fontéchevade. This phylogeny has been upset by the recent fluorine redatings indi-

cating the recency of Galley Hill and Piltown. It now seems that modern man appeared not earlier than the Third Interglacial. Further, this phylogeny fails to take into account the resemblance of Swanscombe to Steinheim and the possibility that Fontéchevade is of the early Neanderthal type.

Figure 4 b is similar to the preceding in that two parallel phylogenetic lines continue through most of the Pleistocene, but here the emphasis is on intermixture during the Third

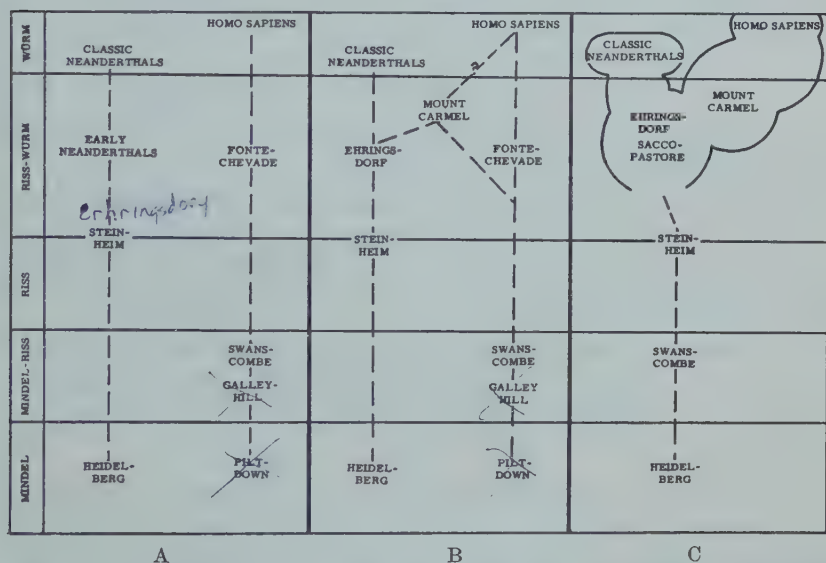


Fig. 4 Phylogenetic diagrams illustrating three interpretations of hominid fossils in Europe and the Near East.

Interglacial between a Neanderthal line and a modern line. This phylogeny suffers from the same defects as the foregoing, as well as its failure to account for the lack of anatomically modern material at the same time levels as the early Neanderthal fossils, and the transitional nature of the fossils from the Near East area.

The conclusions reached here regarding the place of Neanderthal man in human evolution are shown in figure 4 c. Only the Heidelberg mandible affords evidence of Second Glacial

forms on the European continent, forms which may have been ancestral to the later Swanscombe-Steinheim-early Neanderthal group. From the early Neanderthal group, the earliest possible representative being Swanscombe, evolved the classic Neanderthals from the Ehringsdorf and Saccopastore types, a peculiar localized development in western Europe as a result of isolation of that region in the beginning of the Fourth Glacial. Further to the east, from the Mount Carmel population and similar groups, modern man evolved.

SUMMARY

1. The purpose of this paper has been the clarification of the relationships of Neanderthal man.

2. Utilized in the study, from data in the literature, were the crania of 12 early Neanderthals from the Third Interglacial period and 11 classic Neanderthals from the first stadial of the Fourth Glacial.

3. The early Neanderthals were found to resemble modern man in a number of cranial characters, and one population of this group (Mount Carmel) is regarded as ancestral to modern man.

4. The Swanscombe fragment is an early form similar to the Steinheim specimen, and the Fontéchevade skull is tentatively regarded as another possible representative of the early Neanderthal group.

5. The classic Neanderthal fossils are a peripheral development during isolation in the early part of the Fourth Glacial, evolving from forms already in the area previously, i.e., Ehringsdorf and Saccopastore. At the same time modern man was developing further to the east.

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Facial and lateral views of early and classic Neanderthal skulls

Above: Saccopastore II (courtesy Palaeontographia Italica, presso Istituto di Geologia, Pisa);
 Fonte Circeo I; Steinheim (both courtesy E. Schweizerbartsche Verlagsbuchhandlung, Stuttgart).

Below: Skhül IV (courtesy Oxford University Press); La Ferrassie I (courtesy Oliver and
 Boyd, Ltd.).

THE BARCOMBE MILLS CRANIAL REMAINS

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SEVEN FIGURES

The discoverer of the Piltdown cranial remains, Charles Dawson, some time before his death (August 10, '16) found some cranial remains at Barcombe Mills some 4 miles south southwest of Piltdown. At what date this discovery was made is not recorded. In January, 1917, the Barcombe Mills remains were presented by Dr. F. Du Cane Godman to the Geological Department of the British Museum (Natural History) where they now rest. In the Museum Register the Barcombe Mills cranial remains are recorded as having been recovered from "Pleistocene gravel in field on top of hill above Barcombe Mills railway station." A molar tooth is recorded as "probably from the same place (not certain). A[rthur] S[mith] W[oodward]." The Barcombe Mills remains are described for the first time in this paper.

The Barcombe Mills cranial remains, which are all heavily impregnated with iron oxides, consist of the following:

1. A large part of the frontal bone of an adult (E. 644a).
2. A fragment of a right parietal (?) bone (E. 644b).
3. A pair of zygomatic bones, left (E. 644c), right (E. 644d).
4. A mandibular right second molar tooth (E. 645).

The zygomatic bones (3) belong together, but in no way fit the frontal bone (1), and without much doubt represent the remains of another individual. It is not possible to say whether or not the fragment of parietal (?) belongs with the frontal; it is of similar coloration and in a somewhat better state of preservation. It is impossible to say whether

the tooth belongs with any of these bones; like them it is deeply iron-stained a very dark brown.

With certainty, then, it is possible to say that we are dealing here with the remains of at least two individuals (1 and 3), and possibly one (2) or two (4) others.

DESCRIPTION

The frontal bone. Brit. Mus. Geol. Dept. E. 644a. (Figs. 1, 2, and 3). The frontal bone is incomplete, a good portion toward the coronal region having been broken away *post mortem*. Except for some slight breaks at its lateral margins, at the median and left lateral margins of the nasal process, and on the inner table, the bone is well preserved. The zygomatic processes of the frontal are present down to their sutural surfaces, which latter have undergone some abrasion. The supraorbital margins are present, the left showing a supraorbital notch unaccompanied by a foramen, and the right an unusually small supraorbital foramen without an accompanying notch. There are no frontal eminences, and the supraciliary ridges are but slightly developed. The frontal sinus is rather small, measuring 44 mm in length and 21 mm in cranio-caudal height. A remnant of the frontal sinus septum is present.

On the endocranial surface the frontal crest is rather weakly developed, being some 42.0 mm in height and terminating in a marked depression superiorly for the superior sagittal sinus. The diploë and outer table are as in modern man, and unlike the condition in Piltdown I in which the inner and outer tables are extremely thin and the diploë makes up the greater part of the bone.

About half of the orbital roof is present on each side. Though the bone is heavily impregnated with iron oxides, and stained a dark brown from the ferruginous gravel, presumably, in which it lay, its weight is comparable to a similar bone of recent date. The superficial layer of the outer table (the darker areas in the photographs) has peeled away in places.

The greatest thickness of the bone is at its broken left supero-lateral angle, 9.0 mm. At the broken right supero-lateral angle the thickness is 4.0 mm. At the superior broken border in the mid-sagittal plane its thickness is 6.5 mm. The distance from nasion to base of frontal crest is 21.5 mm. Maximum breadth between the zygomatic processes is 110.0 mm; the minimum frontal breadth is 103.0 mm. These thicknesses and dimensions fall well within the range of those for modern man, as does the general form of the bone.

The Barcombe Mills frontal bone is indistinguishable from that of a caucasoid *Homo sapiens*. Comparison with Piltdown I and II shows that except for its lesser thickness the Barcombe Mills frontal has much the same form, but then that would be true of the skulls of many modern caucasoids.

Oakley informs me that the fluorine content of the Barcombe Mills frontal is $<0.1\%$, while that of Piltdown I and II varies between 0.1 and 0.2%. When one considers the fact that on small samples the experimental error is $\pm 0.1\%$, the difference between a recorded fluorine content of 0.1 and 0.4 is not significant.

The fragment of parietal (?) bone. Brit. Mus. Geol. Dept. E. 644b. (Fig. 4.) I have tentatively identified this fragment as a portion of the right parietal bone, from the region of the euryon, that is to say, postero-superiorly at the region of the greatest lateral projection of the parietal bone. However, a doubt must remain as to whether this may not in fact be a portion of the right frontal bone of a second individual. It would be difficult, though not impossible, to make out a case for the latter suggestion: the only place it could occupy would be slightly lateral to the mid-sagittal plane, anterior to the coronal suture. There are no markings on the outer table which would place the bone in the temporal line region, and on the inner table there are none of the typical nutrient foramina which would place it in the supraorbital region. An arterial impression may represent the sulcus for an anterior branch of the anterior division of the middle meningeal artery.

The principal difficulty in accepting this as a fragment of parietal is that the impressions for the branches of the middle meningeal artery are wanting where they are usually encountered, namely, posterior to the arterial impression seen in figure 4. I take this arterial impression to represent the sulcus of a posterior branch of the anterior division of the middle meningeal artery. It sometimes happens that there is an appreciable area between the branches of the anterior and posterior divisions of the middle meningeal artery which exhibits a few, faint, or no arterial impressions, and sometimes the impressions of the posterior division of the middle meningeal artery are themselves faint or wanting. I take this to be the case in the present instance. That the arterial impression represents a branch of the posterior division of the middle meningeal artery is rendered unlikely by the fact of the presence of far too much bone posterior to the impression.

The thickness of the inner table is 3.0 mm as is the thickness of the outer table, the diploë between being very fine. The greatest thickness of the bone is at the antero-inferior angle (fig. 4), namely, 9.5 mm, at the superior angle it is 7.8 mm, at the postero-inferior angle 9.0 mm, and the postero-superior angle 8.0 mm.

It will be seen from figure 4 that the fragment has been broken in two and cemented together. The edges at the break have quite clearly undergone an appreciable amount of abrasion, and so has the inner table. This may account for the shallowness of the arterial impressions. A hole on the posterior piece represents the area from which a sample has been taken for fluorine analysis. The fluorine content of the parietal bone is 0.1%.

The pair of zygomatic bones. Brit. Mus. Geol. Dept. E. 644c and E. 644d. (Fig. 5.) Naturally stained a dark brown color almost the same as the frontal bone and no more heavily mineralized than the latter, this pair of human zygomata do not

fit the frontal in any way. When approximated to the zygomatic processes of the frontal, however one tries, the cranio-caudal height of the orbit is too low, and there is a distinct impression of incongruity. Both bones are of neanthropic type.

The dimensions are as follows:

	LEFT	RIGHT
Inferior zygomaxillare to frontomale temporale	44.3	54.0
Superior zygomaxillare to postero-inferior angle (slightly broken)	35.0	35.0
Frontomale temporale to postero-inferior angle	39.9	51.0
Superior zygomaxillare to postero-superior angle	..	40.0
Superior zygomaxillare to inferior zygomaxillare	..	30.2

A small portion of the maxilla is attached to the right zygomatic bone at the inferior zygomaxillary junction, and above this a portion of the maxillary sinus is evident. The zygomatico-facial foramen is clear. A depression is present in this position on the left zygomatic, the foramen being presumably filled with matrix.

The molar tooth. Brit. Mus. Geol. Dept. E. 645. (Figs. 6 and 7.) This tooth is stained a very dark brown, of precisely the same color as the original M_1 and M_2 in the Piltdown jaw (Brit. Mus. Geol. Dept. E. 594). Broom ('50) has referred to this tooth as "probably M_3 ." There is, however, reason to believe that it is a right second lower molar. In the first place an anterior fovea is present, which in man is rarely the case in M_3 ; and in the second place the wear on the anterior and posterior cusps is characteristic of M_2 (see fig. 6). Mr. J. T. Robinson, who made an independent study of this tooth, confirms this conclusion (*in litteris*). Broom also stated that while the tooth is not at all anthropoid, neither is it quite typical of modern man. I agree with the first but not with the second part of this statement, for I can see no feature of the tooth which is not typical of modern man; the occlusal pattern, the height and form of the cusps, and the form of the root are quite typical of the caucasoid mandibular second molar (figs. 6 and 7).

The measurements of the tooth are as follows:

Total tooth height	19.3
Maximum crown length	10.8
Maximum crown breadth	9.6
Maximum crown height (proximo-lingual cusp) metaconid	5.4
Maximum crown height (disto-lingual cusp) entoconid	5.4
Maximum crown height (proximo-buccal cusp) protoconid	5.1
Maximum crown height (disto-buccal cusp) hypoconid	5.2

As will be gathered from these measurements the cusps are quite high, even though they have been somewhat worn. Comparison of the above measurements with the figures in Gregory and Hellman ('26), table 2, shows that the Barcombe Mills tooth falls within the range of the typical caucoid group.

The fused roots of the tooth are coated with a hard dark brown ferruginous accretion derived from the gravel in which it had lain.

The root is excavated by three pits, at least two of which are the result of caries. The largest of these, shown in figure 7, is on the buccal surface of the root at the cemento-enamel junction, and is 5.0 mm deep, 7.0 mm broad, and 5.0 mm in height. This cavity has also invaded the proximal surface of the root. On the proximal surface at the cemento-enamel junction there is another distinct carious cavity which is 1.5 mm deep, 5.6 mm in width, and 3.0 mm in height. On the lingual surface, in the middle of the root in the sulcus between the fused roots, a small artificially made pit is present, this is 3.0 mm deep, 2.0 mm wide, and 5.0 mm in height. This pit represents the drill hole which was made in 1948 when the dentition was sampled for fluorine analysis.

Comparison of the tooth with M_2 of Piltdown I and M_1 of Piltdown II, leaves no doubt that the Barcombe Mills tooth is of neanthropic type while the Piltdown teeth show the primitive *Dryopithecus* pattern.

As regards the application of the fluorine "test" to the Barcombe Mills material Oakley has said (*in litteris*): "This test, essentially an empirical one, has served admirably to differentiate Lower Pleistocene from later Quaternary ma-

terial in the Piltdown deposits; but apparently fluorine has been relatively deficient in the ground-water of this region since Middle Pleistocene times, so that here the "test" does not serve to distinguish Upper Pleistocene from Recent material. The average fluorine content of the cranial fragments from Barcombe Mills is identical with that of the Piltdown cranial fragments (0.2%). This is within the range of fluorine content of Recent bones in the region, but the Pleistocene age of the fragments at Barcombe Mills (as at Piltdown) is assured by their occurrence as water-worn fragments within a river-gravel on a terrace about 50 feet above the present river. In view of their very low fluorine content one may presume that they are not older than Upper Pleistocene. I would add that the analyses were made by Dr. C. R. Hoskins in the Department of the Government Chemist, London."

It may be concluded, then, that the Barcombe Mills cranial remains are those of a neanthropic type of man. There is no evidence of any close relationship to Piltdown man. The general indications are that the Barcombe Mills remains date from the Upper Pleistocene.

I am much indebted to the Keeper of Geology of the Geological Department, British Museum (Natural History), Mr. W. N. Edwards, and to Dr. K. P. Oakley of the same Department, for permission to examine the Barcombe Mills material as well as the Piltdown remains, and for placing the facilities of the Department at my disposal. Doctor Oakley further kindly supervised the making of the photographs, for this and numerous other kind services I am especially grateful to him.

SUMMARY

At some unrecorded time before his death in August, 1916, Charles Dawson, the discoverer of Piltdown I and II, recovered some human cranial remains from the Pleistocene gravel at Barcombe Mills, some 4 miles south southwest of Piltdown.

These remains, consisting of the larger part of a frontal bone, a fragment of the parietal (?), a pair of zygomatic

bones of another individual, and a second mandibular right molar tooth, are described. It is concluded that the Barcombe Mills cranial remains are of neanthropic type. The results of the fluorine tests on these remains are inconclusive, but the condition of the material is consistent with the suggestion that they are of Upper Pleistocene age.

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OAKLEY, K. P., AND C. R. HOSKINS The fluorine-dating method. *Bull. Brit. Mus. (Nat. Hist.)*, Geol. ser., in press.

PLATE 1

EXPLANATION OF FIGURES

Barcombe Mills cranial remains

- 1 Frontal bone (E. 644a), superior view.
- 2 Same, internal view.





Barcombe Mills cranial remains

- 3 Frontal bone (E. 644a), left lateral view.
- 4 Fragment of a right parietal (?) bone (E. 644b).
- 5 Right zygomatic bone (E. 644d).
- 6 Mandibular right second molar tooth (E. 645), crown view.
- 7 Same, buccal view.

TRENDS IN STATURE OF AMERICAN WHITES AND NEGROES BORN BETWEEN 1840 AND 1924

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FOUR FIGURES

The average stature of an adult population may not remain stable from generation to generation. Environmental conditions, genetic composition and natural selection are among the many factors which can contribute to change. These factors have been grouped under the general term of secular factor as differentiated from the ageing factor which produces changes in stature during the life cycles of the individuals comprising the population. In studies of the effect of the secular factor on maximum stature at least three methods, each with variations, have been applied. The average statures of living subjects at various age levels have been obtained and the trend, if any, observed (Boas, '40); unfortunately, by this method, the effects of both the secular and ageing factors are included. Records of average statures of previous generations have been compared with those of more recent or of present generations (Davenport, '20-'21; Bowles, '32); by this technique the completeness of data of the previous generations cannot be controlled and differences in the methods of taking the measurements may be unduly large. Finally, stature measurements of groups of school children of given ages in two or more successive periods have been compared (Meredith, '41); such data generally do not cover a very long time span.

Meredith ('41) has presented a critical review of the literature bearing on the subject of stature trend. In addition, he

compared statures of school children of the same age in the third and 4th decades of this century. The stature means for the earlier decade were found to be smaller than the corresponding means for the later decade, and he concluded from these findings and from those of other workers that the average stature of white children living in the United States and enrolled at public or private schools has increased during the last half-century. He considered his findings to be a contribution to the "mosaic of research" necessary for deciding between two hypotheses. These hypotheses are, as stated by Meredith, that on the one hand the stature of *Homo sapiens* is increasing progressively from decade to decade and century to century; and that, on the other, there are appreciable changes in stature during certain decades or centuries, but that these changes are cyclic rather than cumulative.

The studies by Davenport ('20-'21) and Bowles ('32) may be cited as examples providing indications of trends in stature occurring in the half-century preceding the period studied by Meredith. The results of these two studies are not in agreement. Davenport found that there had been a reduction of half an inch in mean stature of draft recruits 21-30 years old in the United States Army of 1917-18 as compared with that of recruits of the Civil War, 1861-64. (Both groups were born in the nineteenth century.) This reduction in stature was suggested by Davenport to be one physical result of the new immigration. Bowles' study was based on men who were Harvard students and on women who were students at certain eastern women's colleges; the average statures of both sexes showed a steady increase from the period of 1856-65 to the period of 1906-15.

The purpose of the present study is to offer supplementary data bearing on the question of the effect of the secular factor on maximum stature of individuals born in successive decades. To this end, the length of long bones, a measure which is closely related to maximum stature, is introduced as additional evidence.

MATERIAL AND METHOD

The subjects comprise American White and Negro cadavers (of both sexes) whose skeletons now form a part of the Terry Anatomical Collection and American White and Negro military personnel (all males) whose skeletal remains were made available for measurement.¹ The individuals were born during the period from 1840 to 1924. The total number studied is 1466. The distribution according to source, year of birth, race and sex is summarized as follows:

YEAR OF BIRTH	<i>Terry Collection</i>			
	Whites		Negroes	
	<i>Males</i>	<i>Females</i>	<i>Males</i>	<i>Females</i>
1840-49	9	2	5	3
1850-59	29	11	14	8
1860-69	79	22	45	18
1870-79	68	10	67	23
1880-89	51	8	83	32
1890-99	15	4	65	40
1900-09	4	6	72	38
1910-19	0	0	9	15
	255	63	360	177
<i>Military Personnel</i>				
1900-04	5		0	
1905-09	28		8	
1910-14	77		15	
1915-19	171		25	
1920-24	249		33	
	530		81	

The subjects involved in the Terry Collection have been utilized in an earlier study whereby the effect of ageing on stature was determined from the relationship between long bone length and stature (Trotter and Gleser, '51). In that report the methods employed in measuring the cadaver stature

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and the bone lengths have been described. The stature measurements of the military personnel were made at the time of induction into military service, thus, a number of different stations as well as different observers were involved. From all available information it has been assumed that the stature was taken after the shoes had been removed. The skeletons of this group were available for study at varying lengths of time after induction. The femur and tibia were selected for this investigation because it has been shown that their lengths bear a close relationship (if not the closest of all the long bones) to maximum stature (Pearson, 1899; Dupertuis, '51; Trotter and Gleser, studies in progress). Their lengths were measured by the same methods as described in the earlier paper, viz., the bicondylar length of the femur on the osteometric board and the length of the tibia with spreading calipers from the center of the lateral articular surface of the superior extremity to the center of the inferior articular surface. The average length of the right and left bones has been taken as the length of the bone for the individual.

RESULTS

Average measurements in cm are recorded in table 1 for each race and sex according to year of birth grouped in decennia for individuals from the Terry Collection and in quinquennia for military personnel. The average lengths of femur and tibia are given separately and are also summed. The average stature as measured is recorded for each sub-group and, in addition, a corrected stature is given for the subjects from the Terry Collection.

Need for correction of stature measurements of this group was indicated by the fact that the average age of the sub-groups is closely correlated with the corresponding average year of birth and it is known that stature decreases with age. The average rate of decline in stature due to ageing alone has been determined previously for this Collection and for other data (Trotter and Gleser, '51). It amounts to 0.06 cm per year, with 30 years taken as a reasonable age for the onset of

TABLE 1

Averages of stature and selected long bones (in centimeters) according to year of birth, source, race and sex

YEAR OF BIRTH	NO.	AV. AGE WHEN STATURE WAS MEASURED	STATURE AS MEASURED	CORRECTED STATURE ¹	FEMUR	TIBIA	FEMUR AND TIBIA
WHITE MALES							
<i>Terry Collection</i>							
1840-49	9	83.9	171.6	172.8	46.5	36.5	83.0
1850-59	29	76.0	168.2	168.9	45.2	34.8	80.0
1860-69	79	68.3	170.0	170.3	45.8	35.6	81.4
1870-79	68	58.9	171.2	170.9	45.8	35.4	81.2
1880-89	51	49.3	170.3	169.5	45.4	34.9	80.4
1890-99	15	38.9	171.4	169.9	45.4	35.0	80.4
1900-09	4	33.2	175.8	173.9	47.5	37.2	84.7
<i>Military Personnel</i>							
1905-09 ²	33	32.8	171.2		46.1	35.6	81.7
1910-14	77	29.1	172.9		47.1	36.5	83.6
1915-19	171	24.5	173.3		47.1	36.7	83.8
1920-24	249	20.3	174.8		47.5	37.1	84.6
NEGRO MALES							
<i>Terry Collection</i>							
1840-49	5	85.8	166.2	167.6	45.2	35.9	81.1
1850-59	14	77.1	169.6	170.4	46.9	37.0	83.9
1860-69	45	67.6	171.7	172.0	47.6	37.6	85.2
1870-79	67	59.9	172.5	172.3	47.6	37.9	85.5
1880-89	83	50.0	172.0	171.2	47.2	37.3	84.5
1890-99	65	39.0	172.2	170.7	47.2	37.4	84.6
1900-09	72	29.8	175.6	173.6	48.1	38.3	86.4
1910-19	9	24.3	176.6	174.6	48.0	38.4	86.4
<i>Military Personnel</i>							
1905-09	8	32.1	168.5		46.5	36.5	83.0
1910-14	15	29.8	173.8		48.5	39.0	87.5
1915-19	25	24.8	171.2		48.3	38.4	86.7
1920-24	33	20.1	173.2		48.5	38.9	87.4
WHITE FEMALES							
<i>Terry Collection</i>							
1840-49	2	87.0	150.5	151.9	40.3	30.2	70.5
1850-59	11	79.9	156.0	157.0	42.1	32.9	75.0
1860-69	22	71.2	161.8	162.3	43.2	33.3	76.5
1870-79	10	61.2	162.6	162.5	43.4	33.8	77.2
1880-89	8	52.2	160.1	159.4	43.4	33.5	76.9
1890-99	4	38.0	166.5	165.0	44.4	34.3	78.7
1900-09	6	32.3	162.2	160.3	42.0	32.0	74.0
NEGRO FEMALES							
<i>Terry Collection</i>							
1840-49	3	87.0	155.0	156.4	43.1	34.9	78.0
1850-59	8	80.0	155.2	156.2	42.7	33.3	76.0
1860-69	18	71.0	158.7	159.2	43.7	34.7	78.4
1870-79	23	62.0	162.0	161.9	43.9	34.6	78.5
1880-89	32	49.0	160.9	160.0	43.5	34.5	78.0
1890-99	40	40.3	161.1	159.7	43.6	34.3	77.9
1900-09	38	29.7	161.7	159.7	43.7	34.5	78.2
1910-19	15	23.4	163.3	161.3	44.9	35.6	80.5

¹ Corrections were made by adding 0.06 cm per year (above 30 years) for age and by subtracting 2.0 cm to make cadaver stature comparable with living stature (see text). Statures of military personnel were measured on the living at an age providing approximate maximum stature, thus no correction was needed.

² The 5 cases born between 1900 and 1904 are included in these averages.

decline. Accordingly, the stature was corrected for age by the following computation:

Average measured stature in cm + .06 cm (average age — 30)

An additional correction was employed in obtaining the corrected statures in order to make the values conform to the living statures. It has been found when comparing the separate prediction equations of maximum stature from the length of each of the 6 long bones of upper and lower limbs for the Terry Collection and for the military personnel (White and Negro males from each source) that equations based on cadaver statures tended to be shifted upward; i.e., there was indicated a taller stature for a given bone length than was indicated by the corresponding equation based on living stature (studies in progress). Manouvrier (1892) and Telkkä ('50) have considered 2 cm to be the average difference between living and cadaver statures and thus this correction was made for all sub-groups in which average statures had been determined from measurements taken after death (Terry Collection). This latter correction does not in any way affect the secular trend and was made for the purpose of bringing the statures of the series drawn from the Terry Collection into accord with statures of living subjects, in particular with those of the military series.

It may be difficult to discern what trends, if any, are indicated from the averages of stature for successive periods recorded in table 1, since there are considerable sampling fluctuations and also since the number of subjects varies in the different time periods. (Average statures based on 40 cases have standard errors of approximately 1 cm, whereas those based on as few as 10 cases have standard errors of 2 cm or more.) In order better to reveal the trend, running averages based on figures of three successive time periods were determined for stature and for the sum of the lengths of femur and tibia (table 2). (Thus, sampling fluctuations and possible effects of statistically small samples, which are seen particularly in the earliest and most recent periods, tend to

TABLE 2

Running averages (in centimeters) for stature¹ and for the sum of the lengths of femur and tibia according to year of birth, sex and race

Av. year of birth	MALES				FEMALES			
	WHITE		NEGRO		WHITE		NEGRO	
	Stature	Femur and tibia	Stature	Femur and tibia	Stature	Femur and tibia	Stature	Femur and tibia
1855	170.1	81.2	171.3	84.6	160.0	75.7	158.1	77.7
1865	170.3	81.1	172.0	85.2	161.0	76.3	160.0	78.1
1875	170.3	81.0	171.8	85.0	161.8	76.8	160.4	78.3
1885	170.3	80.8	171.4	84.8	161.8	77.4	160.3	78.1
1895	169.8	80.6	171.8	85.2	160.9	76.3	159.8	78.0
1905			172.4	85.6			160	78.4
1912	173.1	83.6	171.6	86.3				
1917	174.0	84.2	172.6	87.2				

¹ Based on corrected stature for subjects from the Terry Collection (1855-'05) and on stature as measured for the military personnel ('12-'17).

be annulled.) Smoothed curves based on these running averages are presented in figures 1 to 4 in conjunction with curves based on the figures from which the running averages were calculated.

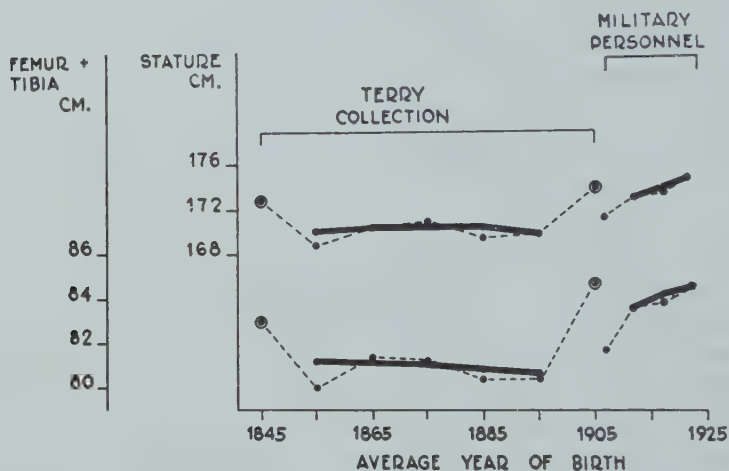


Fig. 1 Curves showing trend in stature and in long bone lengths for White males.

In this and succeeding figures broken lines represent obtained average values (corrected for Terry Collection) and an encircled point indicates that the obtained average value was based on 10 or less cases; solid lines represent running average values (with the exception of the point for 1922 for White males, which is an obtained average and is included because the large number [249] involved in computing this value makes it equally reliable with the running averages).

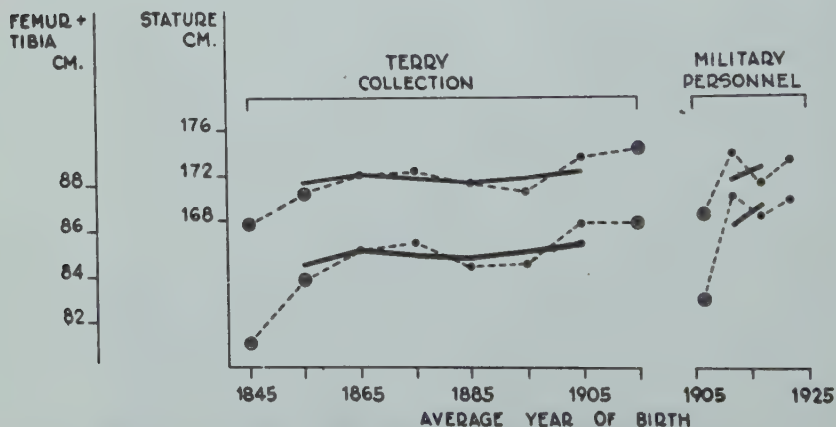


Fig. 2 Curves showing trend in stature and in long bone lengths for Negro males.

DISCUSSION

Terry Collection. The results based on the subjects of the Terry Collection indicate that only relatively small changes in average stature occurred in successive time periods from 1840 to 1909 (tables 1 and 2 and figures 1-4). This finding is substantiated by averages for the length of femur plus tibia

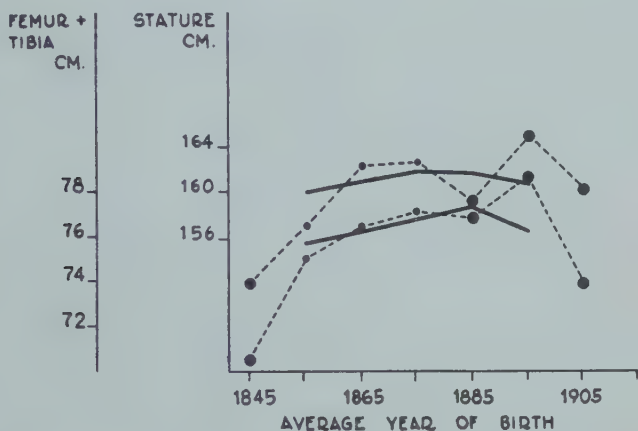


Fig. 3 Curves showing trend in stature and in long bone lengths for White females.

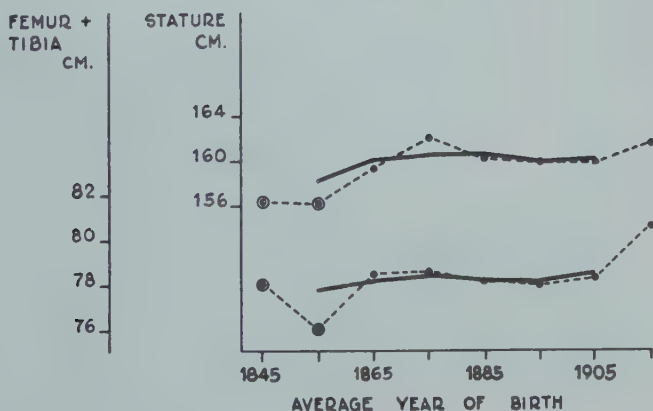


Fig. 4 Curves showing trend in stature and in long bone lengths for Negro females.

which also show only minor fluctuations. Thus, it would appear that the curve for maximum stature of individuals born in the period from 1840 to 1909 was characterized *in general* by a plateau, i.e., by no change or trend.

All 4 smoothed stature curves (for White males, Negro males, White females and Negro females) show a small increase in the decade from 1855 to 1865, the smallest increase occurring in the White male group. The bone lengths likewise show an increase during this period in all but the White male group. The greatest increase in stature appears in the Negro female group and amounts to 1.9 cm. However, even after computing running averages, there are relatively few cases contributing to the 1855 average for each group so that this point is less reliable than the subsequent points.

The curve for the White female group continues to show a rise from 1865 to 1875, then levels off and finally shows a decline to 1895, but the total amount of change in the fluctuations is only 1.8 cm. The number of subjects involved in computing this trend is very small even when running averages are used and, therefore, emphasis on these deviations from the general pattern shown by the other groups for this period is not justified. The stature curve for the White male group is much flatter although it likewise shows a small decline from 1885 to 1895.

The smooth curve for the Negro male group rises after 1885 and this rise is continued up to 1905, or to the end of the period for which data based on the Terry Collection are available. The curve for the Negro females also shows a slight rise beginning, however, at 1895 and extending to 1905.

Again it should be emphasized that the most obvious characteristic of these smoothed curves of stature is their relative flatness. If there were changes in average stature for the total population of American White and Negro males and females born in the period from 1840 to 1909, or to 1919, respectively, they were evidently very slight. In this respect, then, the present data tend to confirm the results indicated by Davenport's study ('20-'21) and to extend the conclusion to include

females. On the other hand, these results are in contrast to the steady increase in stature of eastern college students found by Bowles ('32) for approximately the same period. Since both Davenport's study and the present one may be considered to be based on groups representing a less-privileged economic class as well as including a greater proportion of first generation Americans than the groups studied by Bowles, it is possible that the difference in results may reflect effects of socio-economic factors as well as of immigration.

Military Personnel. The results based on military personnel and, thus, limited to White and Negro males born in the period from 1905 to 1924, show an increase in average stature (tables 1 and 2, and figures 1-4). The trend both in stature and bone length for the White males from this source shows a relatively rapid rise with a total gain of 3.6 cm in stature. Each of these averages except for the first quinquennium (1905-09) is based on a substantial number of cases, and if the average for the 1905-09 group is discounted the increase is nevertheless significant, amounting to 1.9 cm for a 15-year period (1910-24). The average for the 1920-24 period is significantly higher than the averages for either the 1910-14 or the 1915-19 periods when tested by means of critical ratios.

The Negro male military personnel available for study unfortunately comprise a small group. The running averages may be determined for only two quinquennia, indicating the trend from 1912 to 1917. These averages show an increase of 1 cm, which suggests that Negro males, as well as White males, have increased in stature during the first quarter of the twentieth century.

Both Sources. The two periods, affording data on males, jointly extend from 1840 to 1924 with some overlap at the turn of the century. However, no attempt has been made to delineate a continuous curve for either stature or bone length based on data from the Terry Collection and from military personnel. As has been suggested the two groups are not comparable in many respects. Nevertheless, the trends presented by the separate curves for the two sources of data may be compared

and are seen to differ. The average statures and the average lengths of femur plus tibia in successive time periods show only small changes in the Terry Collection group (1840-1919) whereas in the military personnel group (1905-1924) there is a relatively rapid rise. It would appear that at the beginning of the twentieth century an increase in stature of both White and Negro males (data for females not available) has appeared and that this increase is also present in the length of long bones (at least for femur and tibia). It is tempting to hypothesize concerning the causative factors of this increase, among which may be mentioned higher standards of living and advances in medical knowledge. Whatever the causes may be, the definite increase in this century as opposed to the insignificant changes in the second half of the nineteenth century would not lend support to the first hypothesis of Meredith, viz., that the stature of *Homo sapiens* is increasing progressively from decade to decade. Rather, it is suggested that stature increases by spurts and then levels off or even regresses slightly until changing conditions induce a new increment.

The curves for bone length closely parallel the curves for stature and present the same over-all trends. In view of this synchronism and accord between variations in long bone length and stature the advantages of employing long bone measurements as evidence of trend in stature may be enumerated. Measurements can be made by the same individual even when a wide span of birth dates is involved. The effect of the ageing factor on stature does not have to be considered. And, since only the skeleton is required, a long continuous series of data may be available. These advantages are particularly important in dealing with material such as comprise the Terry Collection where the birth span is very great and the only stature measurement had been taken after death.

SUMMARY AND CONCLUSIONS

Trends in stature have been studied in individuals (both sexes of American Whites and Negroes) born between 1840

and 1924. Two sources are represented: the Terry Collection with individuals born chiefly in the nineteenth century, and military personnel born in the twentieth century. In addition, the combined lengths of femur and tibia have been examined in relation to successive time periods.

There obtains a relatively constant average stature devoid of trend for all 4 groups born between 1840 and 1895. There is a tendency for the Negroes (both males and females) to increase slightly in stature from 1895 to 1905. A significant increase in male stature is present in individuals born between 1905 and 1924 (data for Negroes are less conclusive than for Whites because of the smaller sample). Stature trend in American White and Negro populations thus presents minor fluctuations in the nineteenth century followed by a rapid increase in the twentieth century. This total picture of stature trend over a period of 85 consecutive years refutes the hypothesis that stature increases *progressively* from decade to decade.

The length of the long bones in all 4 groups showed fluctuations consistent with stature changes in the corresponding time periods. Thus, the feasibility of utilizing such measures in the study of stature trends is demonstrated and even recommended since the effect of the ageing factor and the need for recorded stature of the subject are eliminated. The scope of accessible data for studies of stature trend is enlarged by means of documented skeletal collections.

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DEVELOPMENTAL AXES OF THE CRANIUM. — Au début de nos recherches sur le mécanisme du développement du crâne, faites en collaboration avec le Docteur Daële, nous avons étudié la situation réciproque de différents points crâniométriques: . . . Les mesures ont indiqué de façon évidente qu'un seul axe était fixe, véritable ligne polaire autour de laquelle les autres points gravitaient, ligne réunissant deux points symétriquement placés à droite et à gauche du plan sagittal et situés au-dessus et en arrière du conduit auditif externe. Il est donc indiqué de prendre cet axe vestibien — perpendiculaire au plan sagittal en un point fixe — comme arête du dièdre formé par les deux autres plans de référence qui seront déterminés dès que l'un d'eux le sera. Il nous a paru logique ensuite de choisir comme plan de référence celui des canaux semi-circulaires externes dans lequel est situé l'axe vestibien. La méthode vestibulaire était dès lors créée. . .

Si on juge une méthode à ses résultats, cette méthode a apporté la notion capitale de la rotation de la fosse cérébelleuse. Elle a révélé l'épanouissement de la voute crânienne en arrière et la formation de la nuque. Elle a expliqué la mécanique si complexe de la fermeture de l'angle sphénoïdal et le déplacement des ses deux côtés, impossible à comprendre si on immobilise sur des schémas superposés, soit le clivus, soit le planum (nous avons appelé ce mouvement: le balancement occipito-facial). Elle a montré que le plan palatin est un plan de base à partir duquel le massif facial accroit sa hauteur en arrière. Elle indique que le masque osseux facial se rabat en arrière à partir d'un point de flexion frontale, qui est bregma des animaux. Elle permet de comprendre comment le volume du crâne est la résultante de transformations multiples qui l'augmente, ou le diminue. Elle illustre le conflit entre le déploiement des clava et la pénétration progressive en coin du bloc facial dans la boîte crânienne. Elle offre encore bien d'autres possibilités d'études. — Delattre, A. Du crâne animal au crâne humain. Masson et Cie, Paris, 1951, pp. 24-25, 101.

HEREDITARY AND ENVIRONMENTAL FACTORS IN TWINNING

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THREE FIGURES

INTRODUCTION

Studies of the etiology of twinning have been concerned with the influence of maternal age and the hereditary mechanism. Attempts to interpret the familial occurrence by a single factor mechanism have not been successful despite the fact that abundant material has been available. An analysis of the environmental factors may illuminate the hereditary factors and their mode of action because it is reasonable to assume that identical traits, whether they have genetical or environmental causes, depend on identical developmental processes. The regional and historical variations in twin frequency in a limited area with a rather stable population may be suitable as a basis of approach to these problems. The fact that the population of Norway has been rather thoroughly examined from the point of view of physical anthropology may be considered as a great advantage to the study of traits related to twinning.

MATERIAL

Data on twin frequencies are available for the last 75 years. They have been summarized in a form suitable for this study by two independent persons and with a varying combination of counties as representatives of eastern, western, middle and northern Norway. Finally all counties have been included because it appeared that the percentages were rather uniform. The regions examined are seen in figure 1. Figures 2 and

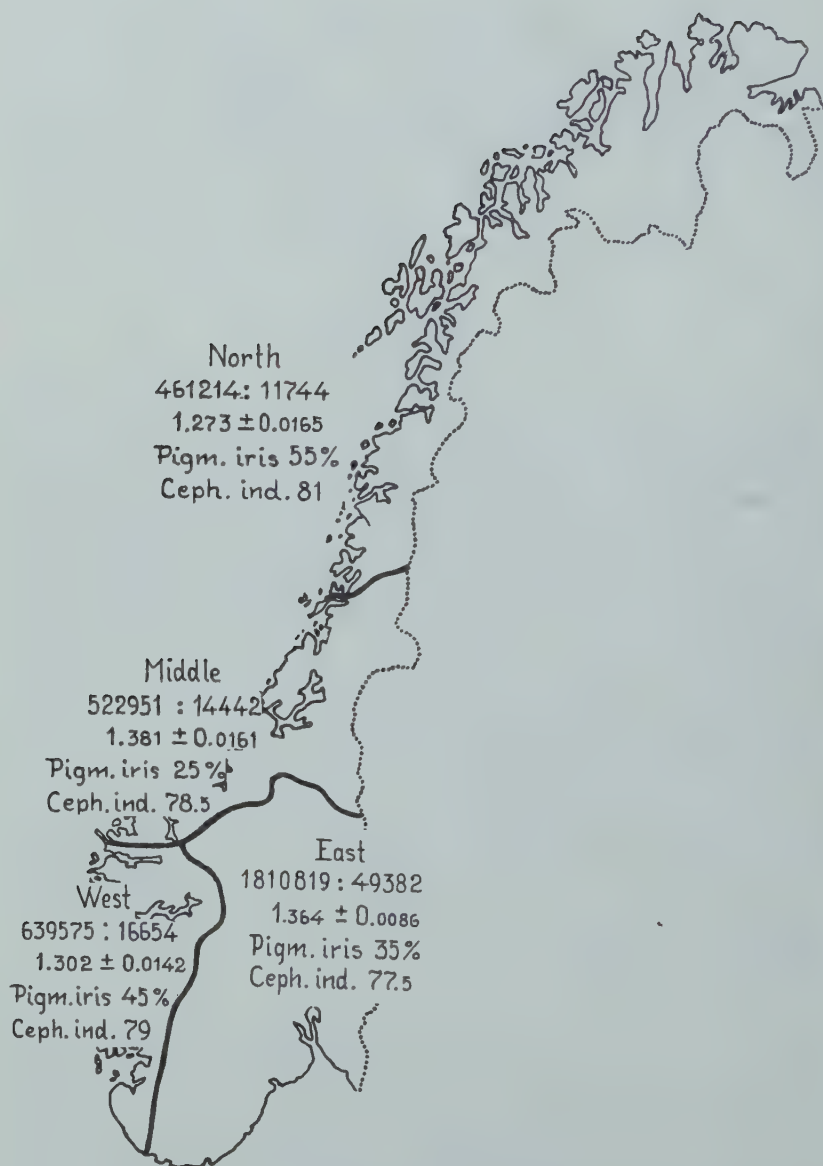


Fig. 1 Percentages of twin births in the regions examined compared with physical characteristics of the population.

3 illustrate the percentages for the periods examined. The percentages give twin births in per cent of all births, stillborn included.

The percentages are higher in the eastern and middle part of the country than in the west and north. The changes in middle Norway closely follow the changes in the east. There

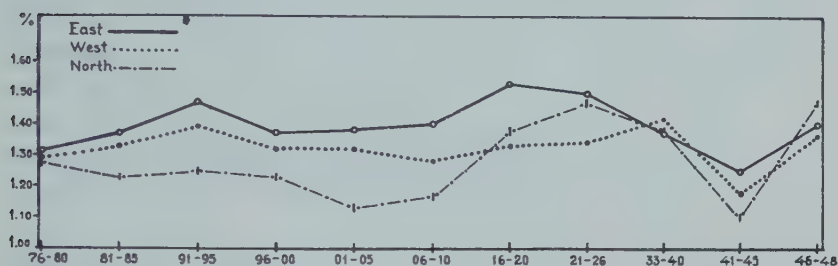


Fig. 2 Percentages of twin births in the east, west and north in successive periods.

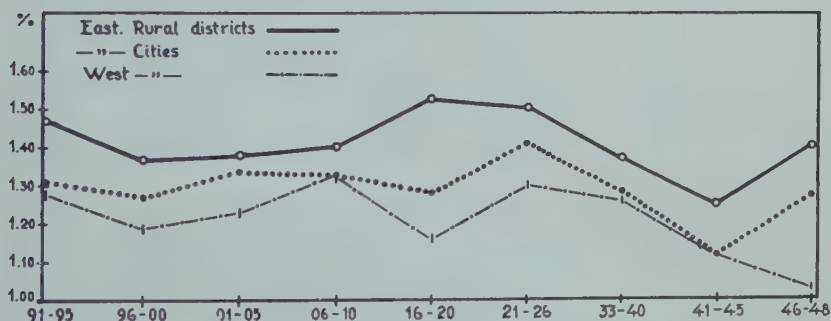


Fig. 3 Percentages of twin births in the rural districts in the east compared with percentages in the cities in the east and west.

has been a continuous increase in the eastern and middle part of the country since 1875. The peak of the curve in these regions is found during 1916-20 and 1921-26, when the percentages in the east were $1.53 \pm 0.036\%$ and $1.50 \pm 0.033\%$ and the differences between east and west were at their greatest: $0.20 \pm 0.066\%$ and $0.16 \pm 0.061\%$. In the west the increase started during 1933-40 and in the north during 1916-

20. In the east a decline set in during 1926-40. The result is that the percentages in 1933-40 were about the same in all parts of the country.

During the war a decrease took place in all regions and the geographical differences reappeared. In the west and the north the decline was steeper. During 1933-40 the percentages in the west and north were $1.42 \pm 0.052\%$ and $1.38 \pm 0.052\%$. In the following period, 1941-45, the percentages were $1.18 \pm 0.054\%$ and $1.10 \pm 0.053\%$ respectively. In eastern and middle Norway the percentages during 1941-45 were $1.25 \pm 0.035\%$ and $1.32 \pm 0.058\%$ against $1.37 \pm 0.032\%$ and $1.43 \pm 0.055\%$ during 1933-40. After the war the percentages became the same as in the prewar period and the regional differences were leveled out.

As is known, twin births are more frequent in rural than in urban districts. The consistency of the regional differences in rural districts and cities indicates that the effect of urbanization is the same in all parts of the country. Figure 3 illustrates the relation between the percentages in the rural districts and the cities in the east, and between the cities in the east and west. Adequate numbers are available for 1891-1948. The decline during the war is about the same in the cities in all regions.

Of all twin births, the percentages of opposite-sexed twins during 1881-85, 1901-10, 1911-20, 1921-30, 1938-40, 1941-45 and 1946-47 were 36.6%, 35.2%, 35.6%, 35.8%, 34.0%, 33.0% and 34.6% respectively. There is no fixed ratio between the total twin frequency and the percentage of opposite-sexed twins. There were relatively many opposite-sexed twins during 1881-85, when the twin frequency was lower than in the beginning of this century. The changes during the war related particularly to dizygotic twins.

The average age of the mothers at childbirth during 1881-85 was 31.8 against 30.5 during 1936-40. The age at birth of twins during 1926-35 was 31.9, or practically the same as at all births during 1881-85. The age at the birth of twins in the latter period was 33.8. It appears from table 1 that

the shape of a curve illustrating the age of the mothers by percentage divisions during 1881-85 is symmetrical, and similar to a curve for the age of the mothers of twins during 1926-35. The shape of the twin curve during 1881-85 reflects more accurately the general birth distribution in relation to the age of the mothers. A curve illustrating the age at all births for the period 1936-40 has its peak towards the left, due to the disproportionate increase of mothers below 29 years of age. The data concern mothers of legitimate births.

TABLE 1

Age distribution of mothers (by percentage) during several periods: for all legitimate births with proportion of twin births in comparable periods; also for twin births

YEARS ALL BIRTHS	AGE 24	25-29	30-34	35-39	40-44	45	YEARS	PERCENTAGE OF TWIN BIRTHS
							1841-85	1.25
1881-85	12.8	25.8	26.4	20.4	11.3	2.5	1886-1900	1.37
1924-29	17.8	29.0	25.5	17.6	8.9	1.2	1921-25	1.47
1929-32	18.2	28.6	26.4	17.5	8.1	1.2	1926-30	1.54
1936-40	20.0	30.4	25.8	16.5	6.5	0.8	1936-40	1.38
1941-45	20.3	30.4	26.2	16.3	6.2	0.6	1941-45	1.20
1946-48	17.8	29.7	27.0	18.1	6.8	0.6	1946-48	1.39
Twin births								
1881-85	7.5	19.5	27.8	27.5	14.6	2.4		
1926-35	11.5	24.3	29.7	23.9	9.9	0.9		

The percentage of illegitimate births is too stable and too low to have any demonstrable influence. During the war the percentage of illegitimate births increased from a prewar level of 6.3% to 7.37%. The frequency of twin births in 20,990 illegitimate births in these years was 0.95%, and in 261,849 legitimate births 1.21%.

The increase of the twin frequency from 1881-85 to 1926-40 took place despite the decreasing age of the mothers. The decrease in eastern and middle Norway during 1926-40 may be due to the decrease of the age of the mothers in this period. During the war no change occurred in the age of the

mothers compared with the prewar years. The small increase in the age of the mothers after the war is out of proportion to the great increase in the frequency of twin births.

It appears from a calculation on the basis of the data from Holland that the percentages of twin births during 1938-40 and 1941-43 were 1.25% and 1.17%. The percentages in Finland and France were stable during the war. The percentages of opposite-sexed twins in Holland in the same periods were 35.27% and 33.13%, and in France during 1931-35 and 1941-45, 33.5% and 32.5% respectively. The decrease in France is remarkable considering the stable total twin frequency. The data indicate a compensating increase of monozygotic twins. During the war the birth rate was high both in Norway and Holland. The percentage of stillborn in Holland decreased from 2.11% in 1940 to 1.84% in 1943. The corresponding figures in twin births were 5.06% and 4.54%. Living conditions were apparently favorable to single pregnancies, and to monozygotic twinning which represents a single pregnancy considering the zygote, and unfavorable to polyovulation and fertilization of more than one egg or to such pregnancies.

Even though the numbers of triplets are small they afford information of interest when compared with the twin frequencies. From 1876-1900 to 1901-26 there is a slight decrease in the frequency of triplet births, in the east from $0.016 \pm 0.0015\%$ to $0.014 \pm 0.0014\%$, and in the west from $0.018 \pm 0.0029\%$ to $0.0145 \pm 0.0024\%$. The high frequency in 1876-1900 may be due to the high age of the mothers. The average age of 45 triplet mothers in this period was 34.1. The slightly higher frequency in the west may be due to the same factor. The low frequency of twin births in the west is not expected considering the age of the mothers. The birth rate has always been higher in the west and the mothers were probably on the average older at childbirth. The age of 55 triplet mothers during 1926-35 was 33.4, or about the same as at the birth of twins in the period 1881-85. Triplet

births tend to occur at a particularly high maternal age. Whereas 30 triplet births occurred in 131,944 births during 1947-48, only 46 such births occurred in 440,953 births during 1931-40. The difference ($0.0227 \pm 0.0041\% - 0.0104 \pm 0.0015\% = 0.0123 \pm 0.0042\%$) indicates that the probability of triplet pregnancies was greater in the postwar years than in any earlier period.

DISCUSSION

The regularity of the data shows that the variations do not depend on errors of registration. As is known, twins, and particularly monozygotic twins, are frequent among stillbirths and miscarriages. In 1876 the percentage of twins among the stillborn was about 7%, and in 1920 about 9%. The increase is adequately explained by a more marked decrease of stillbirths among single births. The increasing percentage of twins in this period probably has causes other than a decreasing frequency of miscarriages favoring the twins. Reliable and unselected data regarding the twin frequency among early miscarriages are hardly possible to obtain. The reasoning in the following is based upon the percentages after the 7th month of pregnancy. These percentages are the result of a series of unknown factors taking effect at conception, fertilization and in the early embryo. The twin frequency depends partly upon hereditary factors, among them the genes involved in the inheritance of twinning and the genes responsible for the prenatal selection in a group. The probability of the presence of a lethal gene is greater in two zygotes than in one. Such genes tend to reduce the percentage of twins by changing dizygotic pregnancies to single pregnancies. For this reason the frequency of dizygotic twins has a bearing on the factors determining differential fertility. Even though there is no increased fertility in twin mothers generally (Dahlberg, '26), dizygotic twinning may be considered as an expression of a high individual fertility in the period in which the fertilization took place.

In France Printzing ('07) found geographical differences in twin frequency very similar to those observed in Norway. The twin frequencies in Norway are distributed as would be expected from the percentages in the neighbouring countries. The general frequency is about 1.65% in Finland, 1.59% in Denmark, 1.46% in Sweden, 1.20% in Scotland and 1.04% in France.

According to Dahlberg, Tschuriloff (1877) attempted to demonstrate that the higher the stature of a population the more numerous are the twins. Dahlberg found, on the basis of data from Italy, a correlation between blue eyes and a high twin frequency. Stature is lowest in northern Norway. It is highest in the middle of the country and about equal in the east and the west (Bryn and Schreiner, '29). According to the last author stature is remarkably variable in the west. As seen in figure 1, the highest frequency is found in parts of the country with a low cephalic index and with a low percentage of individuals with a pigmented iris. During 1933-40 different genotypes may have been obscured by particular environmental factors. The decreasing age of the mothers caused a decline in the east, whereas the improved living conditions produced a maximum effect in the west. The nutrition became increasingly uniform due to the industrialization of the food production.

The data of Dahlberg show that maternal age has the same effect in a country with a high frequency of twins like Finland and in a country with a low frequency like France. The stable frequency in these two countries during the war may be due either to the living conditions or to a lower susceptibility to environmental factors. Official data regarding the caloric content of the food are hardly exact. In Norway it is estimated to have fallen from a prewar value of 3470 per day to 2850 during the war (Strøm and Jensen, '51). The fact that the changes in Norway reflect the regional differences of earlier periods indicates that the response during 1941-45 is partly due to genotypical differences.

Migration and hybridization may partly explain the variations in the periods examined. From 1893 to 1939 these factors had a remarkable influence on the physical traits in the southwest, a borderland between the east and west (Schreiner, '41). The head size increased, and the cephalic index decreased from 80.47 to 79.09. This decrease is greater than expected considering the increase in stature. The percentage of individuals with dark eyes decreased from 18% in 1921 to 10% in 1939. The leveling out of the twin frequencies is connected with a leveling out of the physical differences showing a parallel distribution. Strandskov ('45) found that the twin frequency in the U.S.A. varied more from year to year than expected on a basis of chance, presumably due to genetic heterogeneity.

There is no relation between the twin frequency and the blood groups, according to geographical distribution. There are distinct differences between eastern and middle Norway in the blood groups (Hartmann and Lundevall, '44), whereas a striking conformity is found in these areas regarding twin frequency and the physical characteristics correlated to twinning.

The conformity of the increase in the twin frequency and the increase in stature during the last century is striking. The increase in stature is probably mainly due to improved nutrition and hygienic conditions. These improvements first started in the east and moved to the west and north, followed by an increase in the twin frequency. Schreiner ('24) found that the increase in stature was connected with an earlier menarche, which was found to occur later in small and tall individuals than in women of a medium stature. Menarche occurred later in the north than in other parts of the country and particularly late in the Lapps. A correlation between growth and sexual maturation is what might be expected considering the influence of the sex hormones on the maturation of the skeleton. Good hygienic conditions were found to be connected with an early menarche. The individuals with an early menarche looked like big flourishing children, those

with a late menarche due to bad living conditions like diminutive women with a precocious development of the breasts and the pubic hair. The menarche occurred late in hyperbrachycephalic individuals. The earliest menarche was found in women with a medium cephalic index.

The growth rate of school children was retarded during the war, and menarche probably occurred relatively late. In noting the high birth rate and the low frequency of stillbirths during the war, one has to consider the ratio of first-born to later born and the increasing hospitalization of childbearing women. There is, however, evidence that living conditions had an influence on pregnancy and on the physiology of reproduction. The incidence of premature birth was low. According to the experience of obstetricians, pregnancies were remarkably long and the milder degrees of eclampsia were rare (Smith, '47). The statistics indicate a low mortality from diseases of the heart and circulation, the most common diseases of advanced age (Strøm and Jensen, '51). Considered as a whole, the data indicate a change in the life cycle of the population. This assumption is in accordance with the close relation between growth, maturation, reproduction and life span.

Production of the gonadotropic hormone has been found to be lowered in mice restricted in calories (Boutwell, Brush and Rusch, '48). In contrast to this, activity of the adrenal cortex was increased. A shift was supposed to occur in the pituitary toward the elaboration of the hormones essential to survival at the expense of hormones essential to reproduction. If a restricted amount of food is available the organism has to adjust itself by a reduction of the metabolic rate. Starvation in young growing rats lowered the metabolic rate (Quimby, Phillips and White, '48). The low metabolism as found in castrates is known to increase the lifespan, and to decrease the disparity between the lifespan of males and females which is found in many species (Hamilton, '48). The decreasing average age of the mothers at births is mainly due to birth

control. Probably the symmetrical curve for the age of the mothers during 1881-85 is partly an expression of a longer period of fertility. It is reasonable to assume that a late menarche was connected with a late menopause, slow growth and few twins.

The high frequency of triplets in the first postwar years is of some interest. In rats which previously had been on a restricted diet, an abnormally high metabolism appeared during the period of refeeding (Quimby, Phillips and White, '48). This increase in metabolic rate was not found in rats treated with growth hormone and with testosterone. The increase in triplet births may be due to an increase of the metabolic rate and a change in the hormone balance in the early recovery after a period on a restricted diet.

The data of Bonnevie and Sverdrup ('26), Dahlberg, Davenport ('27) and Greulich ('34) demonstrate inheritance of dizygotic twinning. Dahlberg has stressed the facts indicating the heredity of monozygotic twinning and the interdependence of the two types of twinning. Monozygotic twinning varies, at least in many countries, with the total twin frequency in the same way as dizygotic twinning. Davenport, Fisher ('28) and Greulich have shown that the father plays a role as a twin producer. Fisher is of the opinion that the father has an influence in monozygotic twinning only. The relation between the two types of twinning suggests that they partly share the same factors.

Fisher found a high frequency of monozygotic twins in the family of the fathers of triplets. The frequencies of twins and triplets suggest that the probability of twins and triplets is determined by factors which, even though they may be identical, are relatively but not completely independent in their manifestation. In Fisher's triplet families, twins occur with the same frequency as in twin families, whereas the frequency of triplets is too high to be explainable by a chance repetition of twinning in a twin pregnancy. The high age of the triplet mothers may be responsible for the rupture of

three follicles at a time. The genotype of the father may cause a division of one of the twin embryos in a dizygotic pregnancy.

Bonnevie and Sverdrup regard dizygotic twinning and excessive multiparity as two distinct traits inherited in a different fashion, the former being inherited as a probably monohybrid recessive character, the latter as a dominant trait.

The correlation between physical traits, the rate of sexual maturation, and twinning may be due to genes having a basic effect on growth and differentiation both on the macroscopical and the cytological level. These genes may be integrated in a polygenic block. The integration of genes affecting such unrelated traits as twinning and head shape may be due to a correlated response to selective factors, acting primarily on mutations with a great selective value, on secondarily, characters of minor importance to the organism's fitness. The selective factor may be supposed to be the adaptation of the metabolic rate to the natural resources. The regions examined in Norway illustrate the behavior of twinning in genetically relatively homogeneous populations. The genetically determined differences between the groups are of about the same magnitude as the environmentally determined variations within the groups. The hereditary factors may express themselves in different ways in different groups in different environments. The data do not justify any conclusions regarding traits related to twinning in different groups.

The genes involved may be localized in the sex chromosomes or in autosomes having a particular influence on the physiology of reproduction, growth and sexual maturation. Twinning is correlated to traits depending on multiple genes which express themselves in a continuous variation. These traits and twinning share susceptibility to environmental influences. The evidence favors the supposition that twinning and the different categories of multiple births occur when the cumulative effect of the supposed multiple genes surpasses a certain threshold value, or when the hormone production surpasses a threshold value due to environmental factors.

SUMMARY

The twin frequency is higher in the eastern than in the western and northern parts of Norway. In the east the frequency increased in the years 1875-1920. During the war a decrease took place in the country as a whole. The decrease involved dizygotic twins. After the war there was an increase in the frequency of triplets to above the prewar level. It appears that maternal age alone cannot explain the variations. There is a parallel between changes in stature and the rate of sexual maturation on the one hand, and twinning on the other hand. The variations in the twin frequency are probably partly due to nutritional factors. Twinning is apparently correlated with quantitative traits depending on multiple genes and environmental factors. The data indicate that twinning depends on similar factors. Plural birth occurs when the cumulative effect of the genes involved surpasses a threshold value, or when the hormone production surpasses a threshold value due to environmental factors.

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RECOMMENDATIONS FOR HAIR STUDIES.—Little has been done on the patterns of body hair, on hirsutism, on the relative hirsutism of various races, and on the changes in body hair associated with age. If observers note, during their studies, (1) the regions that bear terminal hair, (2) the amount of terminal hair on each region, and (3) the patterning of the hair on each region, then a body of data will be accumulated for racial and comparative studies. It is very likely that the mode of inheritance of some of the patterns of body hair can be determined, just as Bernstein and Burks and others have analyzed the inheritance of "mid-digital hair." When this is done, hair will play an important role in the present genetic approach to human taxonomy.—Stanley M. Garn. Types and distribution of the hair in man. A chapter (pp. 498-507) in "The Growth, Replacement, and Types of Hair," by J. B. Hamilton et al., *Annals N. Y. Acad. Sci.*, vol. 53, Art. 3, 1951, pp. 461-752.

DERMATOGLYPHICS IN AUSTRALIAN ABORIGINES (ARNHEM LAND)

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The Arnhem Land Expedition ('48; sponsored by the National Geographic Society, the Smithsonian Institute and the Commonwealth of Australia) provided opportunity for the junior author to secure records for observations on the dermatoglyphics of Australian aborigines, a population that had not been previously investigated from this standpoint. The population is now shown to be distinctive. The results are presented here only in brief, since a full account will appear eventually in one of the Arnhem Land Expedition reports to be published in Australia. In keeping with its preliminary character, the present note does not include the extensive tabular data that would be necessary for detailed comparisons with other populations. Such data are available elsewhere, especially in Dankmeijer ('38), Cummins and Midlo ('43), Leschi ('50), Wolfe ('50) and Pons ('51).

MATERIAL AND METHODS

The localities furnishing the material are Yirrkala and Groote Eylandt. Both are in the northern extremity of Arnhem Land, respectively bordering and in the Gulf of Carpentaria. As a group, the subjects are essentially full-blood aborigines (the Australoids of common reference, the Carpentarians of Birdsell, '49).

The prints include the palms and separately rolled finger prints of 90 males and 102 females. In some of the determinations several individuals had to be excluded because of imperfections of the prints. The numbers involved are accord-

ingly indicated in each table. Separately analyzed, the Yirrkala and Groote Eylandt series proved to be quite similar, indicating that inclusion of many related individuals has not seriously vitiated the results. The statistical data recorded here are calculated from the pooled material.

The prints, made on 8" \times 11½" sheets of enameled paper (generously supplied by Mr. Arthur Eckert), included both hands of each individual and separately rolled prints of all 10 digits. Various data (accession number, name, tribe, birthplace, age, sex, location) were entered on the sheet for each subject, and relationships to others of the series, if any, were recorded.

TABLE 1

Frequencies of finger-print pattern types, derived from the individuals represented by complete 10-finger sets of prints: 84 males, 89 females

	FREQUENCIES OF PATTERN TYPES				INDEX OF PATTERN INTENSITY ¹	FURU- HATA'S INDEX ²	DANK- MEIJER'S INDEX ³
	Whorls	Ulnar loops	Radial loops	Arches			
	%	%	%	%			
Male	77.6	21.5	0.6	0.2	17.73	351.0	0.3
Female	73.1	24.9	1.0	0.9	17.21	282.2	1.2

¹ ([Whorls \times 2] + Loops) \div 10.

² (Whorls \div Loops) 100.

³ (Arches \div Whorls) 100.

(Indices calculated from percentile frequencies.)

Analyses of the prints were made according to methods outlined in Cummins and Midlo ('43).

OBSERVATIONS

Fingers

Summarized frequencies of the basic finger-print types are presented in table 1. The overall distinctions, as compared with the other populations on record, are in the abundance of whorls and scarcity of arches; the low frequency of radial loops is noteworthy. The whorl/arch relationships are reflected in the values of the standard indices (table 1).

Males and females differ in the characteristic way, the former having more whorls and fewer arches. This sexual difference, however, depends almost wholly on the Groote Eylandt population, where in males the values are 76.3% whorls and no arches, as against 66.3% and 1.8% respectively in females; in the Yirrkala material the frequencies in males are 79.0% and 0.5%, and in females 78.2% and 0.2%. Such fluctuations are probably merely vagaries of small samples.

TABLE 2

Frequencies of the types of palmar configurations, right and left combined; the implied percentile remainders are the frequencies of open fields

		PATTERNS	VESTIGES	PATTERNS + VESTIGES	NO. OF PALMS R-L
		%	%	%	
Hypo- thenar	M	15.2	5.1	20.3	88-90
	F	14.8	5.4	20.2	102-101
Thenar/ Interdigital I	M	18.6	9.1	27.7	88-89
	F	17.3	10.9	28.2	102-101
Inter- digital II	M	11.8	4.5	16.3	88-90
	F	7.4	5.9	13.3	102-101
Inter- digital III	M	31.1	11.2	42.3	88-90
	F	40.4	10.4	50.8	102-101
Inter- digital IV	M	63.4	9.0	72.4	88-90
	F	57.6	10.4	68.0	102-101

Palms

Configuration types. The frequencies of true patterns and vestiges in each of the configurational areas of the palm are listed in table 2. An impressive aspect of the results is the uniformity of relative frequencies, among the 5 palmar areas, of patterned configurations (patterns and vestiges, as opposed to patternless configurations). This uniformity is not evident in the absolute percentages, since in populations generally the individual areas possess quite different maximum frequencies. For example, patterns and vestiges character-

istically occur with a higher frequency in the 4th interdigital area than in any other, and they are least frequent in the second interdigital area. The uniformity here stressed becomes apparent when the frequencies are compared in relative fashion, in the manner shown by Cummins and Midlo in their figure 146.

Main lines. The palmar main-line index affords the most simple means of summarizing the descriptive formulae that depict the general inclination of ridges on the palm. There is nothing noteworthy in the findings (table 3) beyond the fact that the sample conforms to the trends in other populations with regard to bimanual and sexual differences.

TABLE 3

Palmar main-line indices (method of Cummins). The values are means

	RIGHT	LEFT	RIGHT + LEFT	RIGHT/LEFT RATIO	NO. OF PALMS R-L
Male	9.09	8.19	8.64	111	89-90
Female	8.81	8.24	8.53	107	101-101

Line C is not represented in the index; its special significance lies in the frequency with which the line is missing or reduced. In this series such conditions are present in the following frequencies: right hands, 8.1% and 6.9% in males and females respectively; left hands, 20% and 15.8%. The bimanual unlikeness is typical, and the frequencies themselves are not unusual.

DISCUSSION

The frequencies of pattern types of the fingers vary widely among different populations (see tables in the works cited above). The status of the Australian aborigines may be most concisely presented with the use of the index of pattern intensity. This index applies to the collective patterns of the individual and is a rough measure of their complexity. Whorls, loops and arches represent successive reduction of

complexity; these patterns respectively are assigned values of 2, 1 and 0. The index is simply the total of the digital values for the individual. A person bearing whorls on all digits thus has an index of 20, the opposite extreme being an index of 0 for an individual having arches only. Values 1 through 19 represent various combinations of pattern types: e.g., 10 loops, index 10; 6 loops and 4 arches, index, 6; 5 loops and 5 whorls, index 15. The index by which a population sample is rated is to be viewed as a mean value of the individuals composing the group; it may be actually so calculated, or derived from either the absolute or percentile frequencies of the pattern types.

In the known populations the indices range from about 10 (e.g., Bushmen, Efé Pygmies) to the extreme shown in the Australian aborigines, 17.73 for males and 17.21 for females. Values of about 15 (e.g., Chinese, Batwa) rank high in the catalogue of the known populations, and the present finding in the Australian aborigines is unique. (The nearest approach to the value here reported is Abel's series of 68 Eskimos of East Greenland, 17.13; several writers have questioned the validity of that sample because of the possible concentration of familial peculiarities, composed as it is of several families each with as many as 6, 7 or 8 siblings.)

The high index of pattern intensity in this sample reflects the abundance of whorls and infrequency of arches. Whorl patterns have been quite generally viewed as "primitive" (that is, in the sense of being original, generalized or fetalized as distinguished from the advanced, specialized or derived). This concept, however, has been vigorously challenged by Dankmeijer, by Leshi and by Wolfe. The array of argument on this issue is too involved to be discussed here, and it suffices to say that in their finger-print traits these northern Australian aborigines are either the most "primitive" population yet known — or the least "primitive," the most advanced. Although the question is not yet resolved, we are inclined to favor the alternative of most "primitive." It may be recalled that the question of what is "primitive" may be raised for

many physical traits besides finger patterns, as illustrated by these two opposing appraisals of the population here considered. Birdsell ('49) states: "The general appearance of the Carpentarians is extremely primitive, generalized and non-White. They represent a fourth major racial group equivalent in status with the White, Mongoloid and Negroid groups." Leakey ('50), on the other hand, writes: "As for the so-called 'primitive' characters in the Tasmanian and Australian aborigines . . . it is easier to account for them as excessive specializations from the more generalized *Homo sapiens* types than it is to regard them as modifications of Neanderthaloid forms, and . . . from the point of view of anatomy, the Australian and Tasmanian aborigines should be regarded as examples of one of the most highly specialized of the races of *Homo sapiens* . . . I suggest that it is absurd to continue to regard them as 'primitive' in the sense in which that word is commonly used by anatomists."

In an ingenious analysis of finger-print data, on the basis of the "zones and strata theory" of Griffith Taylor, Wolfe emphasizes the regrettable lack of records for Australoids. The value now available is consistent with his mapping of zones (see his figs. 2-4).

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BRIEF COMMUNICATIONS

REMARKS ON INDOPITHECUS: A REPLY

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ONE FIGURE

In a paper on Siwalik Primates, Pilgrim ('15) described a large lower third (or second) molar as the type of *Dryopithecus giganteus*, and also referred a large first lower premolar (P_3) to *Sivapithecus* cf. *indicus*. For reasons repeated below the present author has tried to show ('50) that both teeth might be referred to the *same* species, and proposed a new genus: *Indopithecus*.

In a recent paper published in this periodical Hooijer ('51), deals extensively with the same premolar. According to him the association with the molar just mentioned is "rather doubtful," while the morphology of the premolar "suggests *Pongo pygmaeus*," the orang. Consequently Hooijer rejects all conclusions drawn by me.

Let us first see what can be said in favor of the association of the two teeth. Both come from the same geological horizon, the Nagri Beds, which are of Middle Pliocene age (not Mio-Pliocene as Hooijer says), the molar from Alipur, the premolar from the famous site of Haritalyangar. Both teeth agree in proportions. In the case of the premolar, because of an extreme antero-posterior shortening, only the transverse diameter can be used for comparison. A simple observation shows that, among the recent anthropoids, as well as among those Siwalik anthropoids of which jaws are known, the transverse diameter of the last molar is in all cases a little *larger* than for the anterior premolar. Average excesses found, based on third molars, are: orang, + 3.2; gorilla, + 2.1; chimpanzee, + 1.0. For *Sivapithecus sivalensis* the value is + 4.8. Comparison with *Sivapithecus indicus* gives - 0.7 — thus *excluding* this form — while with *Dryopithecus giganteus* we find + 1.2. In all cases, for the sake of uniformity, Pilgrim's measurements are used. The last value shows that in its transverse diameter our premolar *is in harmony* with a premolar to be expected in *Dryopithecus giganteus*.

Hooijer, using his own measurements and a slightly different method, viz. the robustness of the teeth, arrives at the conclusion that "by *Dryopithecus* standards the two finds might belong together. Not, however, by orang-utan standards" ('51, p. 89). In this statement I can only see a confirmation of my own results, because *Dryopithecus* as a more generalized form is of greater importance than orang. The living and subfossil orang of the Indonesian region has to be regarded as overspecialized, as already demonstrated by the shape of the skull. Without any doubt the orangs of Sumatra and Borneo, in their present state, are changed by isolation on the islands,



Fig. 1 Teeth of *Indopithecus giganteus* (Pilgrim), from Middle Pliocene Nagri horizon of the Indian Siwaliks. From Pilgrim, '15.

Left: third (or second) right lower molar, surface view. Type specimen (Indian Museum No. D 175) from Alipur.

Center: first right lower premolar, surface view. Referred specimen (Indian Museum No. D 190) from Haritalyangar.

Right: same, external view.

All figures 2 \times natural size.

and it seems very doubtful that Hooijer's "orang-utan standards" will be valid even for the fossil Pleistocene orangs of Java and China, of which until now no skulls or jaws are known.

The molar from Alipur shows some coarse wrinkles; this type of wrinkling would hardly affect the anterior premolar. In Pilgrim's figure (fig. 1, center) the talonid region of the premolar makes a smooth impression; I am, however, not sure but what a single coarse wrinkle, obliterated by wear, is faintly indicated.

Then there is a last argument: it seems highly improbable that two species of giant anthropoids should occur in the same habitat.

For the motives mentioned above I have no reason to reverse my opinion that the two teeth in question — which according to Hooijer's

Dryopithecus standard" might belong together — could be referred to one and the same species, which I have called — differing from *Dryopithecus* proper by reason of a compressed lower anterior premolar — *Indopithecus giganteus* (Pilgrim).

If we now come back to the premolar: could this tooth be referred to orang, as Hooijer suggests? That certain details also might occur in the very variable anterior premolar of the living and subfossil orang is surely the case, but it certainly misses the most typical characteristic of the orang dentition: the fine wrinkling of the crown. According to my observations this wrinkling always affects the talonid, and often the trigonid basin, of the P_3 .

For details I had to rely on Pilgrim's figures, while Hooijer had a cast at his disposal. According to Hooijer the protoconid should be situated in the center, which is certainly not the case in Pilgrim's figure (fig. 1, center). According to Hooijer the tooth is not non-sectorial, but neither in Hooijer's nor in Pilgrim's figures can I detect the anterior projection of the enamel which would justify such a statement.

An important morphological difference with orang is to be found in the shape of the talonid basin. In the orang premolar the basin is generally very shallow and wrinkled (and even "may show wrinkles radiating from its center"; Hooijer, '48, p. 221), while a transverse ridge along the posterior border of the talonid basin is faintly indicated in rare cases. In the Indian specimen, on the contrary, the talonid basin is deep and posteriorly bordered by a marked ridge, which in Hooijer's figure A is even more pronounced than in Pilgrim's figure, published here. It might be added that none of the more than 60 fossil anterior premolars from the Pleistocene of China is comparable with the tooth in question.

A last reason why our premolar from Haritalyangar cannot belong to *Pongo pygmaeus* is its geological age. The find comes from the Middle Pliocene, a formation from which not a single recent mammalian species is known. We cannot accept that such a specialized form as the orang, above all, should extend back into this period unchanged. So it could at best be only a *forerunner* of the orang; but for such a form the tooth is not wrinkled enough, is too large, and is antero-posteriorly too much compressed.

It seems that Hooijer had something like that in mind when he wrote about the tooth that "its morphology suggests *Pongo pygmaeus* (Hoppius), while on the other hand the identification with this species is rendered very improbable on the basis of what we know about the evolution of the dentition of the orang-utan in connection with the geological age of the specimen" ('51, p. 93). I must leave it to the reader to draw his own conclusions from this statement.

Judging from the conditions observed in the living great apes, in connection with the large molar from Alipur, a very different type of premolar would be expected, certainly not a compressed tooth having the quality of a non-sectorial premolar. For that reason it has been suggested by the present author — only suggested! — that there might possibly be a relation to giant hominoids of the *Gigantopithecus* type. Definitive conclusions can only be drawn from more complete material.

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THE PILTDOWN MANDIBLE AND CRANIUM

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In June 1951, I enjoyed the opportunity of examining the original human remains from Piltdown (Piltdown I and II) together with the undescribed remains of two other skulls and a right second lower molar tooth recovered by Charles Dawson at Barcombe Mills, near Piltdown. The Barcombe Mills remains form the subject of a separate communication. In the present paper I wish to present certain observations and the conclusions drawn from them as a consequence of my recent study of the Piltdown remains.

An examination of Piltdown skulls I and II together with the mandible attributed to Piltdown I at once reveals a striking disparity. This does not appear to have been sufficiently emphasized. This disparity is presented by the fact that while the cranial bones of Piltdown I and II are extraordinarily thick the mandible is comparatively remarkably thin, the latter being of about the same general thickness as that of the average mature female chimpanzee. This is, surely, a highly significant point, one which has been quite insufficiently

stressed, for in no known skull of any of the anthropomorpha, extinct and living, indeed in no known primate, does there exist a disparity of this kind between the thickness of the cranial bones and the thickness of the mandible. When the cranial bones are thick the mandible is also thick and massive; when the cranial bones are moderately developed in thickness so is the mandible. Indeed, in the moderately thick-skulled gorilla the mandible is massive, while among the moderately thick-skulled australopithecines the thickness and massiveness of the mandible may be, as in *A. crassidens*, simply enormous. On such morphological grounds, therefore, it would seem highly improbable that the gracile mandible found with the Piltdown cranial bones belonged to the same individual.

This is, of course, not the first time that attention has been drawn to the lack of morphological congruity between mandible and cranium. More than 20 years ago Hrdlička ('30) wrote:

"The handling of the original bone impressed one once more with the great difference that exists between the study of a cast however well made and that of the original. It is very probable that some of the statements made about the jaw and the teeth and some of the conclusions arrived at by some authors, would not have been made had they been able to study the jaw itself.

"The first strong impression which the specimen conveys is that of normality, shapeliness and relative gracility of build rather than massiveness. When, after studying the specimen for a good part of two days, the observer took in hand the thick Piltdown skull, there was a strong feeling of incongruity and lack of relationship, and this feeling only grew on further study. As a rule there exists a marked correlation between the massivity of the skull — particularly if as in this case the upper facial parts were involved in the same — and the lower jaw. A finely chiselled mandible of medium or sub-medium strength belongs as a rule to a skull that is characterized in the same way, and *vice versa*. To connect the shapely, wholly normal Piltdown jaw with the gross, heavy Piltdown skull into the same individual seems very difficult. After prolonged handling of both the jaw and the skull there remained in the writer a strong impression that the two may not belong together, or if they do the case is totally exceptional."

This is precisely the strong impression which a handling of the actual bones made upon me.

Were the mandible of the same degree of massiveness as the cranial bones, its other anthropoid features would be easier to reconcile with the hominid cranial bones, but as it is the disharmony in substance between mandible and cranial bones is so striking it becomes highly improbable that they could have belonged to the same creature. Cer-

tainly in the primates the rule is that the mandible is more massive than the cranial bones. If the Piltdown mandible belonged to the Piltdown cranial bones it would in this respect be unique. In the course of my studies I have examined well over 10,000 human and other primate crania, and I have never seen anything approaching the disharmony in massiveness between mandible and cranium which exists in the case of the Piltdown remains. Pathological and genetic disorders affecting the mandible (micrognathia) alone do occur, but they are extremely rare and, in any event, in no way resemble the condition seen in the Piltdown jaw. The Piltdown jaw is in every way a perfectly normal one. Occasionally one may see a mandible which seems rather small for the cranium to which it undoubtedly belongs, as for example, in Skhul II, but even this is extremely rare and is a very different thing from the disharmony which exists between the Piltdown mandible and cranium. Variability being what it is, it is not impossible that the mandible may belong with the cranium, but the disharmony in massiveness alone, not to mention the numerous other features, renders it highly improbable that the mandible belonged to the same creature as disported the Piltdown cranium.

It has often been argued that together the numerous other anthropoid features of the mandible, both quantitatively and qualitatively, so far outweigh the hominid features that the mandible must be considered to belong to a separate creature, to an anthropoid ape. The cranial bones are those of a man; the mandible is that of an ape. Surely the balance of the arguments is in favor of this conclusion? The fact that the bones were recovered from the same vicinity (though not together and at an interval of several years), that they are stained the same dark brown color,¹ and that they are contemporary does not constitute evidence that they belonged to a single creature.²

"The results of the fluorine test," writes Oakley ('50), "have considerably increased the probability that the mandible and cranium represent a single creature. The relatively late date indicated by the summary of evidence suggests moreover that 'Piltdown Man,' far from being an early primitive type, may have been a late specialized hominid which evolved in comparative isolation. In this case the

¹ Due to the fact that Dawson soaked the bones in a solution of bichromate of potash. See Woodward ('33).

² The fluorine test has shown that the mandible and the cranial bones are of the same age. Oakley and Hoskins ('50) found that all the available bones from the region of Piltdown which were of undoubted Lower Pleistocene (Villafranchian) age contained 2-3% fluorine, while all those which are of known later date showed less than 1.6% fluorine. The Piltdown mandible, the cranial fragments, and the isolated canine tooth, as well as the remains of the second skull found two

peculiarities of the mandible and the excessive thickness of the cranium might well be interpreted as secondary or gerontic developments."

Oakley undertook the determination of the fluorine content of the Piltdown fossils in order to resolve the question of their probable age. It had been claimed by some students that the mandible was Villafranchian while the cranium was of later age. Oakley's tests resolved this point and demonstrated that mandible and cranium were of the same age. And this is what Oakley means when he declares that the probability is increased that "mandible and cranium represent a single creature." In such a context this is indeed so; but in point of fact what is demonstrated is not that the bones belong to the same creature but that they are of the same age.

As for the peculiarities of the mandible and the excessive thickness of the cranium being secondary or gerontic developments, it is quite unnecessary to account for the thick cranial bones by "secondary or gerontic developments," since in all known Lower, Middle, and early Upper Pleistocene men, with the possible exception of Rhodesian man, the cranial bones as well as the mandible are comparatively thick.

Broom ('50) has recently stated that he "now has scarcely any doubt that the Piltdown mandible belongs to the same individual as the associated brain-case. He considers that *Eoanthropus* was a big-brained type of man which evolved on a quite different line from *Homo*. The 'simian shelf' in the lower jaw is probably not an indication of close affinity with the anthropoids, but a specialization due to evolution parallel with that of the modern apes, just as the large brain of this type of man may have been a parallel development to what is found in the *Homo* line."

This is all quite possible but, it seems to me, quite improbable. The cranial capacity of Piltdown man is estimated at about 1,358 cm³.

miles away in 1915, showed very little fluorine (average 0.2%). The Piltdown skull remains are therefore not of Lower Pleistocene age, but belong to a considerably later period. Oakley has provisionally referred them to the last interglacial (Riss-Würm) period ('50), while admitting the possibility that they may belong to the second interglacial (Mindel-Riss).

It requires to be emphasized that the fluorine method does not provide absolute geological dating. In the particular instance of the Piltdown remains it has provided clear evidence that this material constitutes one of the latest elements in the gravel, which contains a mixed assemblage. Naturally one now looks to the geological evidence to see how late the final accumulation of the gravel can be. It has been pointed out that the associated contemporary fauna indicates temperate woodland conditions (Hopwood, '35), i.e., interglacial (since the gravel in the terrace indicates that it is Pleistocene), for the terrace is little more than 50 feet above the present river, and according to physiographers this most probably belongs to the last interglacial, but could conceivably represent a phase of channelling in the second interglacial.

Such capacities are by no means rare in the third interglacial, as witness the Neanderthal types, and even earlier, as is shown by the second interglacial (Mindel-Riss) Swanscombe skull with an estimated cranial capacity of $1,350\text{ cm}^3$, and the lower Upper Pleistocene Tayacian Fontéchevade skull with an estimated cranial capacity of $1,470\text{ cm}^3$. There seems to be no good reason why Piltdown man could not have inherited his cranial capacity from the same general source and in the same manner as Swanscombe, Fontéchevade, and Neanderthal—not to mention other types. It certainly does not appear to be necessary to introduce the *deus ex machina* of parallel evolution to explain the presence of a modern-size brain of so late a representative of *Homo sapiens* as Piltdown man. Except for the thickness of the bones Piltdown man is essentially a *sapiens* type. This fact, taken together with the thick bones and the large brain, makes the anthropoid mandible all the less likely to belong with the cranium.

The simian shelf is characteristic of the great apes. It is not found in any form of fossil ape-man or man. The probabilities of its ever developing in a hominid jaw, particularly one which went with a *sapiens* cranium, seem to me extremely low.

One of the arguments which has carried great weight in the Piltdown controversy has been the statement that there is no evidence that anthropoid apes or other non-hominid primates ever existed in Britain. If true this would be a telling point, but the fact is that it is not quite true. Dr. Kenneth Oakley has drawn my attention to the fact that as long ago as 1854 Owen ('45) described and figured the fragments of a right maxilla with M^2 in situ, from the brick earth series at Grays Thurrock in Essex, and over 40 years ago Hinton ('08) described the distal end of a humerus of another macaque, not unlike *Macacus inuus*, from the Norfolk Forest Bed. The Forest Bed is generally accepted as Middle Pleistocene. The Forest Bed is widely held to be Lower Pleistocene. A macaque is not an anthropoid ape, but the presence of such a catarrhine primate in Pleistocene England increases the probability of an anthropoid ape having lived and survived in the forests of England right into the Pleistocene. Fossil macaques from the Upper Villafranchian (Schreuder, '45) and Miocene apes are well known on the continent of Europe, and in regions as close to England as France. The coast of France is a matter of 21 miles from the coast of England at the present time, and at its narrowest part the English Channel is now barely 100 feet deep; as Flint ('47) points out, this must have been replaced by an isthmus during the lowered sealevels of the glacial ages. The presence of the fossil remains of such southern (warm-climate) types as *Elephas meridionalis*, *Hippopotamus*, lion, and hyena strongly suggests that during certain interglacial periods

there was a land connection between England and France. The geological evidence renders it even more probable that such land connections existed at various times during the Tertiary, and it is a possible hypothesis that during this period the anthropoid ancestors of the owner of the Piltdown mandible originally migrated into England. However, until the remains of such forms have actually been discovered in England this argument must remain but a speculation. What is not a speculation is that the Piltdown mandible is morphologically disharmonic with the cranium, and that non-human catarrhine primates have been discovered in Lower and Middle Pleistocene deposits in England, a fact which increases the probability of the possible existence of anthropoid apes in that country.

It is submitted that these are points which are worthy of more attention than they have thus far received.

I have to thank the Keeper of the Department of Geology (Natural History), Mr. G. N. Edwards, and Dr. Kenneth P. Oakley of the same Department for permission to examine the Piltdown remains. I am also indebted to Dr. Oakley, and to Mr. J. T. Robinson of Pretoria, South Africa, for much stimulating discussion, without which the present paper would probably not have come into being. I am indebted to Professor Hallam L. Movius, Jr., for drawing my attention to Schreuder's paper.

SUMMARY

The difference in massiveness between the Piltdown mandible and the Piltdown cranial bones being so great, it is suggested that on these grounds alone the mandible most probably does not belong with the cranium. Together with the great number of other anthropoid traits characterizing the mandible, it is suggested that the disharmony between the latter and the cranium is too great for these to belong to a single individual.

The argument that no primates other than man have ever been found in England is shown to be unfounded, since the remains of two Pleistocene macaques have been discovered in England and described by Owen in 1845 and by Hinton in 1908.

The presence of fossil macaques and anthropoids in France and of probable land connections during the Tertiary, and as late as the Pleistocene, make very real the possibility of the migration of such forms into England. Hence, the occurrence of the mandible of an anthropoid in the same vicinity and contemporaneously with that of a fossil man as late as the Middle Pleistocene, and possibly the third interglacial, is a possibility somewhat less remarkable than has hitherto appeared.

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OBJECTIVITY IN RACE CLASSIFICATIONS

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At this writing the recent book by William C. Boyd on "Genetics and the Races of Man" has been reviewed by two competent anthropologists whose knowledge of genetics I respect: J. N. Spuhler in the *American Anthropologist*, and J. B. Birdsall in this Journal. In general they seem to have evaluated the book fairly, but I would like to dissent on one point — on the matter of objectivity in serological race classification. Birdsall says, "*Although no phenotypic characters have been utilized* [in this classification], it is interesting to note that these categories do little violence to the major racial groups usually agreed upon by non-genetical anthropologists" (p. 221, italics mine). Spuhler does not go as far as this, yet he seems to imply the absence of influence by the phenotype simply by not mentioning it. To this

limited extent at least, both of these reviewers support Boyd's assertion that "The genetic classification of races is more objective and better founded scientifically than older classifications" (p. 274)¹.

Leaving aside the relative qualities of the basic data of science, it is debatable whether the genetic classification of races rests upon a higher degree of objectivity than do the morphological classifications. Apparently the geneticists' claims to objectivity in this connection are restricted to the manipulation of the figures in the literature relating to gene frequencies. Only by ignoring what is involved in the assembling of these figures can it be said that "no phenotypic characters have been utilized" in the classifications based thereon. In the case of blood groups, as Rowe ('50, p. 199) has pointed out, essentially all the available data have been derived from peoples selected directly or indirectly by their phenotypic characters. In America, for example, serologists have carefully distinguished between Whites, Negroes, Indians, and various Asiatics; in Australia they have distinguished between Whites and the aborigines. If this were not so, and if those doing the blood grouping had tried to be completely objective, they would have disregarded external appearance and combined the findings on everyone within a locality. This, we all recognize, would have been silly, because it would have ignored known human migrations, like the European settlement of the Americas and of Australia. I repeat, then, that blood group data have been subjected to selection largely, if not entirely, on the basis of phenotypes. In addition, a great effort has been made to eliminate from blood-group series even the "mixed breeds." Under these circumstances and as regards objectivity, the manipulation of gene frequencies is not far different from sorting anthropometric figures.

Since the collection of blood group data thus has been intimately associated with phenotypes, it would be startling indeed if the distribution of the blood group genes did not parallel the less understood (but no less real) genes involved in the production of phenotypic characters. However, in pleading his special case, Boyd does not take this agreement as evidence that the older classifications have some merit. Instead, he says "Far from discouraging us, this should be a sign that our new methods are not doing so badly" (p. 273).

¹ Since these lines were written the September issue of this Journal has appeared with its timely editorial by Strandkov and Washburn. The point that they make about the inseparability of anatomical traits and gene frequencies in matters of race is precisely what I have in mind. Any genetic concept of race that ignores anatomical traits is unrealistic.

This situation reminds me of Dr. Hooton's subjective typing of the skulls from Pecos. Here, it will be recalled, the validity of the types was said to be proved by their close metrical identity to races which they resembled. Thus Hooton's Pseudo-Negroids showed a low mean difference when compared with African Negroes. In view of the selection of traits that suggested the Negro, this metrical agreement is no longer looked upon as surprising, much less as evidence of racial relationship.

Special pleaders are apt to ignore alternate interpretations. However, the applications of genetics to anthropology do not need special pleading; their value is clearly evident. Progress from the easily recognized phenotype to the less easily identifiable genotype is slow. The contributions of human genetics that Boyd otherwise has ably summarized have been called revolutionary; they are better characterized as evolutionary.

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MOUNTAIN PEOPLES OF IRAQ AND IRAN

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Anthropometric data have always been scanty on the dwellers in the mountainous crescent having one horn in southeastern Anatolia and extending through northeastern Iraq to the Zagros Mountains, Pusht-i-Kuh and Zardeh Kuh midway between Dizful and Isfahan. In general, this area has been relatively inaccessible to foreigners except beside the roads which have been built during the present century. The natural independence of the people makes them loathe to submit to the calipers.

In this vast mountain complex dwell Kurds in southeastern Anatolia,¹ Iraq and Iran; Assyrians from the rugged peaks of the Hakkari Mountains between Lake Van and Lake Urmia (Rezaiyeh); Lurs in the Zagros and Pusht-i-Kuh; and at the southern horn of the crescent, the famed Bakhtiari tribe, who still make their annual migration from their cool summer quarters high in the Zardeh Kuh eastward to the low country toward Isfahan or westward onto the fertile plain beside and across the Karun River.

These 4 groups, being mountaineers, possess relatively similar cultures, which may be divided into settled inhabitants and nomads. The former live in flat-roofed mud-brick or stone houses, the latter in black camels' hair tents. The former practice agriculture based on rivers, surface water or shallow wells.

During the past 26 years I have obtained anthropometric data² on Kurds, Assyrians, Lurs and Bakhtiari tribesmen. As a result, it is now possible for the first time to make some statistical comparisons on these 4 important groups.³ In this short note I shall deal with the more significant criteria, namely the stature, head measurements and cephalic index and nasal profile and index on about 1,000 men. The tables speak for themselves, but attention must be called to the following:

(a) These mountain peoples are all related to some degree, although the Assyrians probably belong to a different racial stock with links in the Caucasus.

(b) The Assyrians are the tallest, the Bakhtiari the shortest. Among the Kurds those of northwestern Iran are the tallest, but the 646 Kurds fall close to the mean of 1665 for the peoples of south-

¹ No anthropometric data are available on these Kurds, but according to Mr. C. S. Gulbenkian, who examined my front and profile photographs of Kurds from the Zakho region of Iraq, there is considerable similarity in racial type between the Kurds living on each side of the Turkish-Iraq border. The Kurds of southeastern Anatolia are brachycephalic and leptorrhine, the majority with convex noses. For the location of the Kurdish tribes of Anatolia, Iraq and Iran see my tribal map of Iraq accompanying "The Anthropology of Iraq, Pt. 1, No. 1, The Upper Euphrates," Field Museum of Natural History, 1940.

² For additional information see Henry Field, "Contributions to the Anthropology of Iran," Field Museum of Natural History, vol. 29, pp. 1-706, 1939; "The Anthropology of Iraq, Pt. 2, No. 2, Kurdistan," Peabody Museum Papers, vol. 46, No. 2, 1952; the Report of the Peabody Museum-Harvard Expedition to the Near East, 1950; Bibliografia in Boletín Bibliográfico de Antropología Americana, vol. 9, pp. 325-333, Mexico City, 1947; "Reconnaissance in Southwestern Asia," Southwestern Journal of Anthropology, vol. 7, No. 1, pp. 86-102, 1951; "Reconnaissance in Saudi Arabia," Journal Royal Central Asian Society, vol. 38, Pt. 2, pp. 185-197, 1951; and "Bibliography, 1926-51."

³ See footnote in table 1.

western Asia. The Lurs of Pusht-i-Kuh are short, but their relatives in the Khurramabad area are considerably taller.

(c) The Lurs of central Luristan have the longest heads, the Kurds of Sulaimaniya the shortest. In breadth the Lurs of Khurramabad are the narrowest, the Assyrians the widest. The Assyrians are hyperbrachycephalic, the Lurs of Khurramabad mesocephalic. The Kurds and Bakhtiari are brachycephalic. The Lurs are dolichocephalic and the fact that the Kurds of the Sinneh (Iran) district are

TABLE 1

*Anthropometric data on mountain peoples of Iraq and Iran*¹

GROUP	NO.	STATURE	GOL	GB	CI	NH	NB	NI
Kurds I	133	1660.2	181.17	149.95	82.62	54.74	35.00	64.26
Kurds II	234	1660.5	181.98	151.96	83.52	54.06	34.97	65.06
Kurds III	230	1662.3	179.73	152.53	84.96	53.86	34.49	64.96
Kurds IV	597	1661.1	180.93	151.72	83.88	54.14	34.88	64.82
Kurds V	49	1672.5	186.10	145.05	78.65	56.40	36.60	64.09
Lurs I	68	1639.5	188.02	143.55	76.49	55.45	35.70	64.95
Lurs II	52	1686.3	189.99	140.68	74.25	62.22	35.75	57.42
Bakhtiari	147	1622.5	183.65	149.65	81.65	55.19	37.10	67.65
Assyrians I	106	1705.2	180.45	154.03	85.17	63.10	35.03	51.72

¹ Kurds I are from Zakho in northern Iraq; Kurds II from Rowandiz in northeastern Iraq; Kurds III from Kirkuk and Sulaimaniya; Kurds IV include Kurds I, II and III; and Kurds V are from northwestern Iran. Lurs I are from the Pusht-i-Kuh and Lurs II from between Khurramabad and Dorud in central Luristan. The Assyrians were studied in 1934 at Hinaidi Camp near Baghdad. The Chehar Lang of the Bakhtiari tribesmen were examined during April, 1950, in Khuzistan. Kurds I, II, III and IV and Lurs I and Assyrians were obtained during the Field Museum Anthropological Expedition to the Near East, 1934. Kurds V from the Sinneh area of northwestern Iran were recorded at Habbaniya in western Iraq. The Lurs II and the Bakhtiari were also measured during the Peabody Museum-Harvard Expedition to the Near East, 1950.

mesocephalic is probably explained by their intermarriage with Lurs. The dolichocephalic element among the Bakhtiari is probably caused by intermarriage with the Lurs which is in accord with their oral tradition.

(d) The nasal profile is one of the most important racial criteria in southwestern Asia, with particular emphasis on the convex and straight categories. For example, more than two-thirds of all Kurds of Iraq and Iran, the Lurs of Pusht-i-Kuh and the Bakhtiari tribesmen possessed convex noses. About half of the Assyrians and the Lurs of central Luristan had straight noses.

(e) The majority of all the Kurds of Iraq and Iran and most of the Lurs and Assyrians (97.17%) were leptorrhine. Very few platyrrhine individuals were recorded or seen. The Bakhtiari are divided into mesorrhine (49.66%) and leptorrhine tribesmen. Their convex nasal profile links the Bakhtiari with the Iranian Plateau Race and upholds my observations that this convexity is concentrated among the peoples of western Iran. Eight of the 9 groups are leptorrhine with near uniformity among the Assyrians, many of whom are fair-haired, light-skinned and possess blue eyes.

(f) The blond element in these 4 groups is linked either to the peoples of the Caucasus or to the dwellers in the Altai or Pamirs. In 1934 I saw many blonds among the North Osetes near Dzhaudzhikau (formerly Vladikavkaz) on the northern flank of the Caucasus.

Additional anthropometric data and racial type photographs from southeastern Anatolia, the Caucasus (especially the Kurds near Lake Goktcha), and the peoples along the southern periphery of Soviet Central Asia from the Murghab River to the Tien Shan Mountains, will provide the necessary links in the chain of racial evidence.

THE KENTUCKY SKULL RIG¹

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TWO FIGURES

Devices designed to hold and orient anthropoid skulls are among the earliest craniometric instruments. From Charles Bell's pivot (see Topinard, 1885, p. 130) to the latest development which I wish to present here, there have been many varying greatly in complexity and style. Martin ('28) and Topinard illustrate a number of these. Since a historical survey of anthropometric instruments has been made by Lucile E. Hoyme of the United States National Museum, it is unnecessary to duplicate such information here. I am indebted to Miss Hoyme (personal communication) for the few background notes I have included.

¹ Demonstrated at the 20th annual meeting of the American Association of Physical Anthropologists, Ann Arbor, Michigan, March 19-21, 1951.

The author wishes to thank Nathalie F. S. Woodbury for preparing these notes for publication.

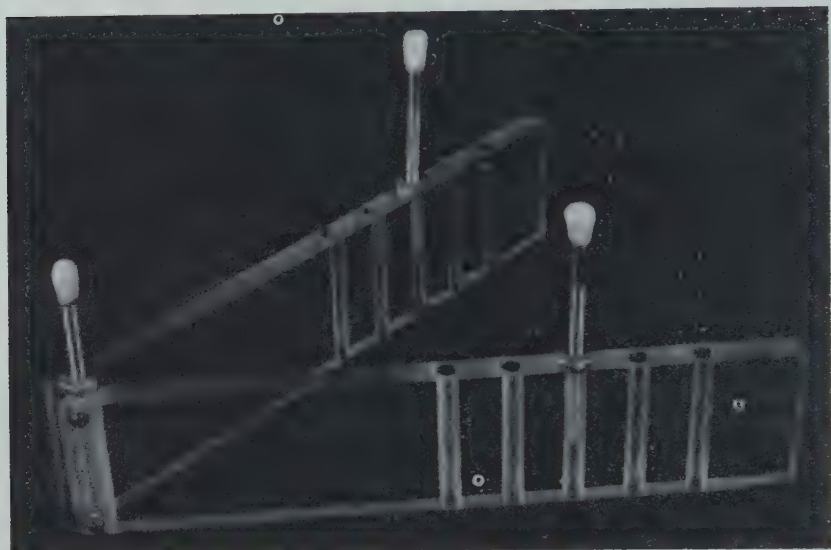


Fig. 1 The Kentucky Skull Rig opened and set for displaying the ordinary human skull. (Photograph, Museum of Anthropology, Univ. of Ky.)



Fig. 2 A fragmentary Adena male adult skull displayed upon the Kentucky Skull Rig. In the front row view the lines of the rig have been inked out. (Photograph, Museum of Anthropology, Univ. of Ky.)

There are two general categories of skull holders: those that are integral parts of measuring instruments, and those designed to support the skull for display, photographing, and observation. The Kentucky rig falls into the latter category. In principle it is similar to one shown in an article by Hooton ('18, pl. 7) on Icelandic skulls. However, by using modern materials, plexiglass, aluminum, and latex, a support has been produced that is easy to handle and unobtrusive, yet stronger and more accurately adjustable than the older models that depend on steel and wood. Although never dominant in a display or photograph, and in fact easily camouflaged, the rig is very pleasing in design and in the best tradition of modern museum display. (See figs. 1 and 2.)

The Kentucky Skull Rig is designed to support any primate skull in the eye-ear plane. The requirements of the anthropologist have been skillfully met by the fabricator, Dr. Karl O. Lange, of the Physics Department of the University of Kentucky.

The holder is easily adjustable. The V-shaped support of plexiglass has three latex-capped, threaded, aluminum pegs, one at the hinged apex and one on each wing, which can be set at different levels $1\frac{1}{16}$ " to 2" above the plastic base. The pegs are held in position by nuts which can be screwed up or down. The wing pegs can be placed in any of 5 holes, spaced $1\frac{1}{2}$ " between centers, over a range of two inches. By spreading or closing the sides of the V or by moving the pegs, large adult primate skulls or even infant or small primate skulls can be supported with or without mandible. In the ordinary specimen the hinge peg supports the palate, and the rear two support the skull base just inside the mastoid processes. Even a novice can quickly and easily make height adjustments with one hand, lifting the peg free or up partially in the hole in order to turn the nut.

The dimensions of the support, which can be folded flat for easy storage or opened to an angle of 105° , are as follows:

<i>Base</i>	
Height	$1\frac{3}{8}$ "
Thickness	$\frac{1}{2}$ " (closed), $\frac{1}{4}$ " (one side only)
Length	$5\frac{1}{8}$ "
Distance from apex to first hole	3"
<i>Spread (open 105°)</i>	
Between hindmost holes	8"
Between foremost holes	$4\frac{1}{4}$ "
<i>Pegs</i>	
Total length	$2\frac{3}{8}$ "

Figure 2 shows a skull displayed on the rig from the two standard views. In the front view the white outlines of the rig have been

obliterated with India ink. A more complete specimen would, of course, require less retouch work.

The Kentucky Skull Rig is manufactured by Lange Instruments, Route 5, Richmond Road, Lexington, Kentucky. It is priced at \$2.25 each or \$25.00 a dozen.

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REVIEWS

TROY, THE HUMAN REMAINS. By J. LAWRENCE ANGEL. Suppl. Monogr. 1. 40 pp., 8 tables, 14 plates. Princeton Univ. Press, 1951.

There are two ways of looking at ancient skeletal material: merely as a static record of craniological and osteological characteristics of an early people; or as a dynamic interpretation of biogenetic potentials in a population sample. Angel has, in all his studies, emphasized the latter viewpoint, and has pioneered, I think, in restoring meaningfulness to what were formerly dismissed as "only skull studies." Whether we ride a genetic hobbyhorse or not, skulls and bones will continue to be found — usually in statistically inadequate numbers — in mounds, in caves, in village areas, and so on. In most instances, the small series is unique: "That's all there is, there ain't no more!" It is obligatory that we learn all we can from the material, make it available to the larger pool of collected data, and interpret broadly and conservatively. Angel's report richly meets these requirements.

There are available the bones of 17 individuals from the prehistoric levels, 11 from historic, plus a "greater number represented by fragments too broken to measure." The descriptions, photographs, and measurements of all material are given in full and precise detail, enabling other students to use basic data.

Angel bases his conclusions upon the concept of cranial "type," which is admittedly subjective, "as one of a set of groups which are morphologically separable in the eyes of the observer partly because

of social and partly because of genetic segregation." Accepting this premise, he speaks first of a "Trojan type," and then of other types which go to form it. The Trojan type has diverse headform (from long, narrow and high, to medium-short and variable height), lambdoid flattening, deep cerebellar region, frequent "Hausform" vaults, narrow forehead, marked alveolar prognathism, short to medium stature, and hyperplatymeria. Contributory types are Small Mediterranean, Iranian, Basic White, Alpine, Eastern Alpine, Dinaric-Mediterranean, and Armenoid. Obviously, the "Trojan type" is an extremely composite racial entity. Even so, on the basis of discrete morphometric and morphological details—such as missing third molars, alveolar prognathism, lambdoid flattening, cerebellar bulge, and temporal flattening—Angel feels that there is evidence of some degree of genetic continuity. It is this kind of careful, detailed analysis which, in my opinion, validates both the type concept and possible genetic inferences. I agree with Angel when he deplores "the relative incompetence of present metrical and observational methods to analyze thoroughly the genetic relationships of different populations," but I feel, too, that studies such as his are laying the foundation for a real genetic insight into early skeletal material formerly deemed too isolated or too incomplete to give some idea of genetic continuity. With Angel's studies, craniological analysis has come of age.

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THE CHORDATES. By HERBERT W. RAND. Blakiston Co. 862 pp., 609 figs., 1950.

Professor Rand indicates that this volume grew out of the need for a single text that surveys all the major aspects of the sprawling subject of comparative anatomy. As in human anatomy, the time seems to have come when a distinction ought to be made between a text for students and a reference work for professionals. Rand's new volume is a well illustrated and unexcelled summary of facts, and will be widely used as a beginner's text. For this purpose it is too big and it encounters almost insoluble problems of logical organization. As a reference work even its 862 pages are insufficient, and there are no bibliographies.

The first 300 pages are devoted to "Basic Structure" — the elements "common to all vertebrate anatomy." Many items in this section are common only to the members of certain classes or orders, and the student is soon buried in minutiae that make sense only in physiological, embryological, histological and comparative anatomical contexts that are not supplied until later sections are reached. When frequent repetitions occur in the "Comparative Morphology" section the function of "Basic Structure" emerges as a gigantic vocabulary lesson. Figures 91 and 97, for instance, are reprinted as figures 454 and 459. Such repetition occurs in most other texts in this field. If the student reviews the book and reorients himself to the whole subject after a first reading it is a question whether an author need present him with so curiously disjointed a pattern.

The section on Comparative Morphology pulls in the facts and points of view of embryology, histology, adaptation, function and evolution. Emphasis may be judged from the fact that the fishlike vertebrates (which constitute more than a majority in the phylum) are disposed of in 50 pages, the reptiles in 40, birds in 56 and mammals in 235.

There is a section on "History, Aim and Method" which does everything except suggest that the subject of comparative anatomy is still living and growing. Most texts fail in this respect. The "Epilog" is a "whence and whither" section that must have been fun to write. The author is still living in the Age of Enlightenment, full of progress and hope. Summing up the evidence of the evolution of vertebrate anatomy and of human culture, he suggests raising the suborder Anthropoidea to the taxonomic dignity of Class VII in the phylum. Falling in with this suggestion one might add that the promotion should be made soon. The way things are going there is not much time left.

Although *The Chordates* is almost entirely a new book it has a familiar look because most of the illustrations have been widely used for some time in the author's other works and elsewhere. A few textual details seem dated. The attempt to teach kidneys within the conceptual framework of pro-, meso-, and metanephros, while adequate for amniotes, is unfortunate in the broader context of the chordates. The antique theory of heart evolution through 2-, 3-, and 4-chambered stages is presented, but the "2-chambered" fish heart of p. 67 is figured correctly on p. 65 with the 4 chambers labeled. Haeckel's biogenetic "law" will probably be accepted in its original form by the student who reads this book in spite of the author's occasional qualifying after-remarks. The classic list of types of homology is presented without any suggestion of the paradoxes and sometimes insoluble difficulties met in study of actual cases. Orthogenesis is presented

as a still vital idea, but orthoselection is not mentioned, and in general the contribution of genetics to this field is slighted. In common with practically all texts, the account of gastrulation is grossly inaccurate, predating the results of vital-staining experiments that have appeared in profusion since the 1920's.

Since this review might give another impression, it should be made clear that *The Chordates* is immediately welcome as one of the fullest, most accurate, most clearly written and generally useful texts in the field of comparative anatomy.

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UPPER LIMIT FOR TOTAL MUTATION FREQUENCY.—[Muller] has stated that it is unlikely that the total mutation rate in man exceeds 1.0, because, if we assume an approximate equilibrium between the origin of new traits through mutation and their removal through selection, this implies an average of one "genetic death" per individual; it seems to him unlikely that the species could "tolerate" more than this. This concept of "genetic death" is, however, a statistical abstraction that can be misleading. All of us fall far short of the theoretically perfect representative of the species. The various members of a species can each carry a considerable handicap as long as the species as a whole is capable of successfully resisting efforts to dislodge it from its particular ecological niche by other (genetically handicapped) species. Man with his highly developed nervous system and social organization may have developed mechanisms for compensating for theoretical genetic death, mechanisms not operative in lower forms. In other words, the tolerable limit of genetic inefficiency depends upon both inter- and intraspecific selective pressures. Man may have so far negated the interspecific competitions, and so far mitigated and altered the usual intraspecific competitions, that relatively high mutation rates per generation can be tolerated (and on occasion turned to advantage) as long as the integrity of the organ responsible for his success, the brain, is not threatened. Furthermore, the survival of an individual under competition is as a rule not determined by the presence of single genes but by constellations of genes. Each individual who dies for reasons primarily genetic removes some

40,000 genes from circulation. One "genetically determined" death may therefore effect the disappearance of a number of mutations, particularly if there is any tendency for the distribution of unfavorable genes in a population not to follow a normal frequency curve. For these reasons it would seem premature, until more detailed data are available to postulate a genetically acceptable upper limit for total mutation frequency.—James V. Neel and Harold F. Falls. The rate of mutation of the gene responsible for retinoblastoma in man. *Science*, vol. 114, no. 2964, October 19, 1951, pp. 419-422.

INDEX

A BO and RH blood types among the ewes of West Africa	371	Dermatoglyphics in Australian aborigines	455
A-B-O , M-N and Rh-Hr blood factors in the Dominican Republic with reference to problem of admixture	127	Developmental genetics and evolutionary meaning of the metopic suture	193
Aborigines , dermatoglyphics in Australian	455	DUPERTUIS , C. W., AND J. A. HADDEN, JR. Reconstruction of stature from long bones	15
Ageing , effect of, on stature	311		
ALVAREZ , J. DE JS. Studies on the A-B-O, M-N and Rh-Hr blood factors in the Dominican Republic with special reference to the problem of admixture	127	E FFECT of ageing on stature	311
AMERICAN ASSOCIATION OF PHYSICAL ANTHROPOLOGISTS . Proceedings of the twentieth annual meeting and list of members	225	EHRICH , R. W. <i>Review of Ashley Montagu's Statement on Race</i>	375
Anatomical relationship predisposing to lumbo-sacral fusion	149	Ewes of West Africa , ABO and RH blood types among	371
ANGEL , J. L. Troy, the Human Remains. <i>Reviewed by</i> W. M. Krogman	478	F IELD, HENRY. Mountain peoples of Iraq and Iran	472
Anthropoid ape , questions relating to a new, from Mio-Pliocene of the Siwaliks	79		
Anthropometry of Jewish infants in Palestine	297	G ARN, S. M. Use of middle-phalangeal hair in population studies	325
ARMATTOE , R. E. G. ABO and RH blood types among the ewes of West Africa	371	Genetics and physical anthropology	261
ASHTON , E. H., AND S. ZUCKERMAN. Cranial indices of Plesianthropus and other Primates	283	Genetics and the Races of Man. By William C. Boyd. <i>Reviewed by</i> Joseph B. Birdsall	219
Australia and New Guinea blood types of natives	71	GLEESER , G. See Trotter, M.	311
		GOFF , C. W. Mean posture patterns with new postural values	335
BARCOMBE Mills cranial remains	417	GREGORY , WILLIAM KING, Editor. The Anatomy of the gorilla. <i>Reviewed by</i> W. E. Sullivan	113
BIRDSALL , JOSEPH B. <i>Review of</i> William C. Boyd's Genetics and the Races of Man	219	GREULICH , W. W. Growth and developmental status of Guamanian school children in 1947	55
Blood agglutinogens in Chinese and Negroes , incidence of some new	115	Guamanian school children , growth and developmental status of	55
Blood factors in the Dominican Republic with reference to problem of admixture	127		
Blood types of natives of Australia and New Guinea	71	H ADDEN, J. A. JR. See Dupertuis, C. W.	15
Bone , Wallbrook frontal	5	Hair , use of middle-phalangeal, in population studies	325
BOYD , WILLIAM C. Genetics and the races of man. <i>Reviewed by</i> Joseph B. Birdsall	219	HALEVI , H. S., Y. M. BROMBERG AND A. BRZEZINSKI. Studies in anthropometry of Jewish infants in Palestine	297
BROMBERG , Y. M. See Halevi, H. S.	297	Healed tooth fractures on a Krapina Neanderthal	369
BRZEZINSKI , A. See Halevi, H. S.	297	Hereditary and environmental factors in twinning	441
C HINESE and Negroes, incidence of new blood agglutinogens in	115	HILL , W. C. O. Note on the nomenclature of certain hominidae	367
Cranial remains , the Barcombe Mills	417	Hominidae , note on nomenclature of certain	367
CUMMINS , H., AND F. M. SETZLER. Dermatoglyphics in Australian aborigines (Arnhem Land)	455	HOOLIJER , D. A. Geological age of Pithecanthropus and Gigantropus	265
D ENTAL and medical research, physical anthropology in	211	HOOLIJER , D. A. Questions relating to a new large anthropoid ape from the Mio-Pliocene of the Siwaliks	79
		HOWELL , F. C. Place of Neanderthal man in human evolution	379
		HOWELLS , W. W. Factors of human physique	159

- Human evolution, place of Neanderthal man in 379
- Human physique, factors of 159
- I**RAQ and Iran, mountain peoples of 472
- J**APANESE of Northern Honshu, male somatotypes among the 347
- Jewish infants in Palestine, anthropometry of 297
- K**ALLAY, J. Healed tooth fractures on a Krapina Neanderthal 369
- KAY, M. P. See Sanger, R. 71
- Kentucky skull rig 475
- KOENIGSWALD, G. H. R. VON. Remarks on *Indopithecus*: a reply 461
- KRAUS, B. S. Male somatotypes among the Japanese of Northern Honshu 347
- KROGMAN, W. M. Physical anthropology in dental and medical research 211
- KROGMAN, W. M. *Review of J. L. Angel's Troy, the Human Remains* 478
- L**UMBO-SACRAL fusion, anatomical relationship predisposing to 149
- M**ALE somatotype among Japanese of Northern Honshu 347
- Mean posture patterns with new postural values 335
- MILLER, E. B., R. E. ROSENFELD AND PETER VOGEL. Incidence of some of the new blood agglutinogens in Chinese and Negroes 115
- MONTAGU, M. F. ASHLEY. Barcombe Mills cranial remains 417
- MONTAGU, ASHLEY. Statement on Race. *Reviewed by Robert W. Ehrich* 375
- MONTAGU, M. F. ASHLEY. The Piltdown mandible and cranium 464
- MONTAGU, M. F. ASHLEY. The Wallbrook frontal bone 5
- Mountain peoples of Iraq and Iran 472
- N**EANDERTHAL man in human evolution, place of 379
- Nomenclature of certain hominidae, note on 367
- Note. W. M. Krogman, fifth recipient of the Viking fund medal and prize in Physical Anthropology 107
- P**HYSICAL anthropology in dental and medical research 211
- Physique, factors of human 159
- Pittdown mandible and cranium 464
- Pithecanthropus* and *Gigantopithecus*, geological age of 265
- Population studies, use of middle-phalangeal hair in 325
- R**ACE classifications, objectivity of 470
- RAND, H. W. *The Chordates. Reviewed by W. W. Ballard* 479
- ROSENFELD, R. E. See Miller, E. B. 115
- S**ANGER, R., R. J. WALSH AND M. P. KAY. Blood types of natives of Australia and New Guinea 71
- Scientific responsibility 1
- SETZLER, F. M. See Cummins, H. 455
- SNOW, C. E. Kentucky skull rig 475
- Stature, effect of ageing on 311
- Stature, reconstruction of, from long bones 15
- STEGGERDA, MORRIS, 1900-1950 97
- STEWART, T. D. Objectivity in Race classifications 470
- STEWART, T. D. Scientific responsibility 1
- STRANDSKOV, H. H., AND S. L. WASHBURN. Editorial. Genetics and physical anthropology 261
- SULLIVAN, W. E. *Review of W. K. Gregory's the Anatomy of the Gorilla* 113
- Statement on Race. By Ashley Montagu. *Reviewed by Robert W. Ehrich* 375
- T**HE chordates by H. W. Rand. *Reviewed by W. W. Ballard* 479
- THIEME, F. P. Anatomical relationship predisposing to lumbo-sacral fusion 149
- The Anatomy of the Gorilla. By W. K. Gregory, Editor. *Reviewed by W. E. Sullivan* 113
- TORGERSEN, J. Developmental genetics and evolutionary meaning of the metopic suture 193
- TORGERSEN, J. Hereditary and environmental factors in twinning 441
- Trends in stature of American Whites and Negroes, 1840 and 1924 427
- TROTTER, M., AND GOLDINE GLESER. Effect of ageing on stature 311
- TROTTER, M., AND G. GLESER. Trends in stature of American Whites and Negroes born 1840 and 1924 427
- Troy, the Human Remains by J. L. Angel. *Reviewed by W. M. Krogman* 478
- Twinning, hereditary and environmental factors in 441
- V**IKING Fund medal and prize in Physical Anthropology received by W. M. Krogman 107
- VOGEL, P. See Miller, E. B. 115
- W**ALLBROOK frontal bone 5
- WALSH, R. J. See Sanger, R. 71
- WASHBURN, S. L. See Strandkov, H. H. 261
- Z**UCKERMAN, S. See Ashton, E. H. 283

